STROMATOPOROIDS OF THE KAYBOB REEF, ALBERTA

THE UNIVERSITY OF ALBERTA

STROMATOPOROIDS OF THE KAYBOB REEF, ALBERTA

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OF MASTER OF SCIENCE

DEPARTMENT OF GEOLOGY

by

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The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled:

Stromatoporoids

of the

Kaybob Reef, Alberta,

submitted by Norman Robert Fischbuch, B. Sc.,

in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

One hundred thin sections of core chips from the Beaverhill Lake formation of the Kaybob area and from the Slave Point (?) formation of the North Peace River area of Alberta, were prepared. From this, twelve species of the genera Actinostroma, Stromatopora, Stachyodes and Amphipora are figured and described.

The above named genera are also found in the Lower Cairn formation of the Rocky Mountains, the Waterways formation, and the Swan Hills member of the Beaverhill Lake formation in the nearby Swan Hills field. The correlation suggested by Stromatoporoids agrees with a brachiopod correlation. Amphipora are not diagnostic.

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CHAPTER ONE

INTRODUCTION

INTRODUCTORY STATEMENT

Since April of 1957 several wells in the Kaybob area of Alberta, 150 miles northwest of Edmonton, have penetrated an oil bearing stromatoporoidal ~~carbonate~~ limestone sequence in the Beaverhill Lake formation of Devonian age. Although the areal extent of the field has not as yet been defined, it appears to lie mainly in townships 63 and 64, range 19, west of the 5th meridian. Coring of the Beaverhill Lake producing section has revealed up to 200 feet of stromatoporoidal limestone. Cores of this stromatoporoid "zone" were studied from three wells: Phillips Kaybob "A" no. 7-22 at the north end of the field; California Standard Iosegun Lake no. 7-33 to the south; and Phillips Kaybob "B" no. 5-5, a marginal well to the east. The faunas obtained from these three wells are quite similar. Stromatoporoids such as Amphipora and Stromatopora found at Kaybob also occur in the so-called Slave Point of the North Peace River area. Some polished specimens of Waterways (outcrop) fauna and Home Virginia Hills core samples from the Swan Hills member also appear similar to the Kaybob forms.

The fauna is difficult to describe as destruction of

the microstructure by recalcification and dolomitization is common. In core specimens all structures were altered to a certain extent but most of the larger structures were complete. Most comparative outcrop specimens show poorer preservation.

PURPOSE OF THE STUDY

The purpose of this study is to describe a group of stromatoporoids found within the Beaverhill Lake formation in the Kaybob area of Alberta. It is hoped that their formal description will assist in correlation with other areas in outcrop and in subsurface. Stromatoporoids have been selected because they are by far the most abundant fossil of the Kaybob producing horizon and the few brachiopods present are long ranging. Thus they seem to be the most logical group to eventually establish whether the producing formation is Middle or Upper Devonian in age. Lack of any work on stromatoporoids in Western Canada makes it difficult to use correlative species and in some cases even genera. Most named species referred to herein were originally named from the Middle Devonian, with the exception of one, Actinostroma sp. A. However, the Beaverhill Lake specimens were not referred to either Middle or Upper Devonian but rather, a comparison was made between the stromatoporoid faunas of several areas in western Canada.

COLLECTION OF SAMPLES AND PREPARATION OF SLIDES

Specimens used in the formal descriptions were obtained exclusively from well cores. Polished sections of outcrop specimens were used only for rough comparisons. The Phillips Kaybob "A" no. 7-22 and "B" no. 5-5 were sampled by the writer at the Phillips core house in Calgary while the California Standard Iosegun Lake no. 7-33 was sampled at the California Standard core house in Edmonton. Cores from the North Peace River wells were sampled at the University of Alberta. The chips were examined with a 10 power hand lense and if the orientation of a colony or a fragment of a colony could be determined a tangential section and vertical section were cut. If the orientation of a colony could not be established even though skeletal structure was apparent a random section was cut. The sections were polished, mounted on frosted glass slides and ground to a thickness such that that the skeletal structure could be best observed. These slides were then examined under a Zeiss Opton binocular microscope using transmitted light. In one instance (Plate 1, Fig. 1) reflected light was used. If the skeletal structures were well enough preserved to be measurable the slide was set aside and used later in a description or as a supplement to a description. In some cases destruction of microstructure by alteration

could not be noticed until thin sections were made. For this reason many of the thin sections were rejected.

PHOTOGRAPHS AND PLATES

Photomicrographs of the slides used in the descriptions were taken, parts of which were cut out and used in the plates.

The major features of each photomicrograph were traced and reproduced on negative paper following the same arrangement as the plates. This avoided retouching the plates and facilitated the labelling of the skeletal parts.

ACKNOWLEDGEMENTS

The writer wishes to express his sincere appreciation to Dr. C. R. Stelck and Dr. S. J. Nelson for their direction and guidance in the writing of this thesis.

Phillips Petroleum Company gave the writer permission to sample the Kaybob "A" no. 7-22 and "B" no. 5-5 cores and California Standard Company gave permission to sample the Iosegun Lake no. 7-33 core.

The North Peace River cores were obtained as a gift to the University of Alberta from Canadian Seaboard Oil Company.

CHAPTER TWO

STRATIGRAPHY AND PALEOECOLOGY

GENERAL STATEMENT

The producing member of the Kaybob field is a reefoid and bioclastic unit seemingly representing the introduction of shallow water marine conditions after a temporary withdrawal of the sea toward the end of Middle Devonian time. Reefoid conditions in Middle Devonian seas are known to have existed from Great Slave Lake to Manitoba (Presqu'ile dolomite, Winnipegosan dolomite). These bioherms were stopped in growth by super-saline and emergent conditions. A low region was left in the Kaybob area while to the northwest the Peace River high stood out as a row of hills giving source for various sand bodies such as the Gilwood sand. An incipient phase of brackish to fresh, or anhydritic beds (Slave Point?) sometimes overlies the Gilwood sand before the reappearance of reefoid material into the columnar section. The Slave Point formation is overlain by the shales of the Hay River formation in the Great Slave Lake area and there seems to be almost continuous deposition there. For this reason it is assumed that reflooding of central Alberta about the beginning of Upper Devonian time came from the north. As the seas that laid down the Hay River shales flooded around the barrier

of the Peace River high, fine clastics were laid down in the McMurray area (Waterways formation), limestones and calcareous shales in east-central Alberta (Beaverhill Lake formation) and stromatoporoidal carbonates in the embayments along the foothills regions (Flume formation). Stromatoporoidal reefs were also laid down in the embayment south of the Peace River high giving the present productive units of the Kaybob, Virginia Hills and Swan Hills oil-fields. Continuing deepening of the waters stopped reef growth in the Kaybob area itself and reefing was then confined to the margins of the embayment giving the later "D3" producing reefs of the Sturgeon Lake trend to the northwest on the flanks of the Peace River high and of the Leduc-Rimbey trend to the southeast.

STRATIGRAPHY

The Beaverhill Lake formation was named in 1950 by the geological staff of Imperial Oil Limited. The type section was taken from subsurface cores of the Anglo-Canadian Beaverhill Lake no. 2 well located in Lsd. 11, Sec. 11, Tp. 50, R. 17, W. 4th Mer., Alberta. The top of the Beaverhill Lake formation was picked at the base of the first "fragmental limestone" or Cooking Lake formation, and the base above the ~~first~~ highest occurrence of silt or fine sand of the Elk Point formation. In the type well the Beaverhill

Lake formation is 722 feet thick and consists of a lower fragmental limestone and an upper argillaceous limestone. To the north the fragmental limestones become interbedded with shales and argillaceous limestones.

In the Kaybob area the Beaverhill Lake formation is approximately 425 feet thick and consists of dark argillaceous limestone in non-producing areas. In producing areas there is a basal non-porous argillaceous limestone with various beds of Amphipora and Stachyodes. Above this is a mixed stromatoporoidal and clean limestone which may contain either numerous large stromatoporoids or Amphipora or both. Both the fossils and matrix are porous. An argillaceous limestone overlies the productive beds. The Beaverhill Lake formation in the Kaybob area is underlain by a greyish black shale bed of possible Elk Point age, and overlain by a shale unit that includes the Cooking Lake, Duvernay and Ireton equivalents.

The Upper-Middle Devonian contact is known to occur below the top of the Cooking Lake formation and above the Elk Point formation as the Upper Devonian genus Timanites occurs in the outcrop equivalents of the Cooking Lake formation in the Rocky Mountains (Miller and Warren, 1936). The genus Stringocephalus of Middle Devonian age is found in the underlying Elk Point formation (Crickmay, 1954).

The Beaverhill Lake formation therefore probably carries the Upper-Middle Devonian contact.

The reefal member of the Beaverhill Lake formation in the Kaybob area appears to correlate with the Lower Cairn formation of the Rocky Mountains, since Stearn (1958) in his study of Lower Cairn stromatoporoids has described species of Actinostroma, Stromatopora, Stachyodes and Amphipora. All of these are present in the Kaybob reef. The sequence of faunas is also similar in that Amphipora is very abundant at the base and the larger stromatoporoids are common near the top in both units. The correlation may be in part homotaxial if the environment of stromatoporoidal deposition shifted westward with the advance of the sea.

No stromatoporoid specimens are described herein from the nearby Swan Hills field but polished core chip specimens from the Swan Hills member (Beaverhill Lake formation) of that field appear to have affinities with the genera: Actinostroma, Stachyodes and Stromatopora of the Kaybob reefal member. The brachiopods Atrypa sp., cf. A. independensis Webster and Atrypa albertensis Warren are common to both the Swan Hills member and the base of the Kaybob reef. All indications, stratigraphic, lithologic, electric log and paleontological ~~show~~ are that the Kaybob reef is an equivalent of the Swan Hills and Virginia Hills reefs, i.e. the

Swan Hills member.

Fong (1959) correlated the Swan Hills member with the Waterways formation on the basis of the brachiopod faunas. Polished sections of Waterways stromatoporoids show two well preserved specimens of Actinostroma. Therefore, the Lower Cairn, the Kaybob reefal member, the Swan Hills member and the Waterways formation all contain similar stromatoporoids.

This work on stromatoporoids was completed before Gayle Koch did his brachiopod analysis (1959) of the cores of the nearby Swan Hills field. It seems to indicate that considerable stratigraphic information may be obtained by careful examination of stromatoporoid faunas within the Devonian limestones in Western Canada if a properly calibrated suite ~~could~~ can be established for comparison purposes. Since this study has been undertaken additional excellent specimens of stromatoporoids, especially Actinostroma and Stromatopora have been revealed by further coring in the Kaybob field.

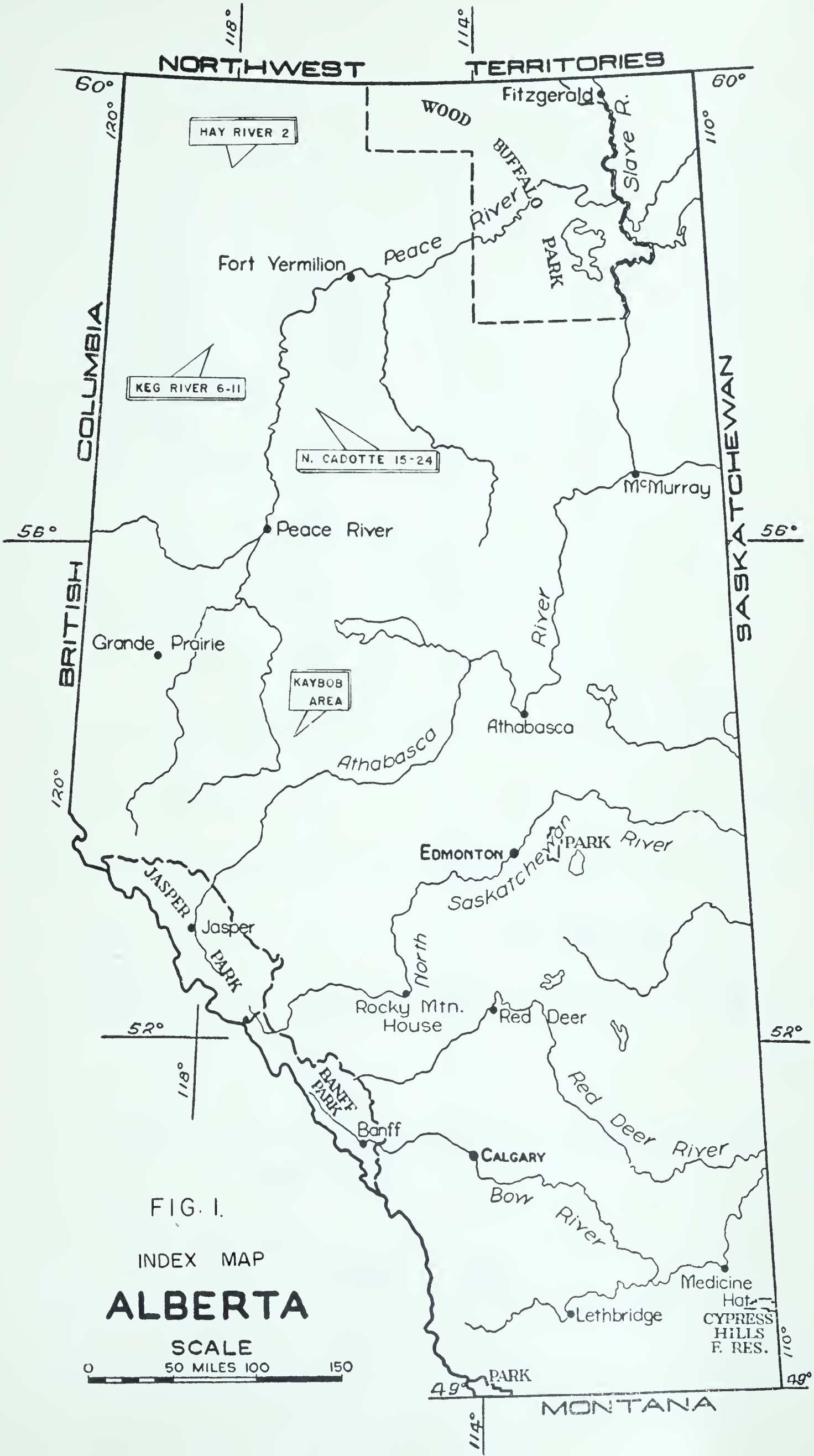


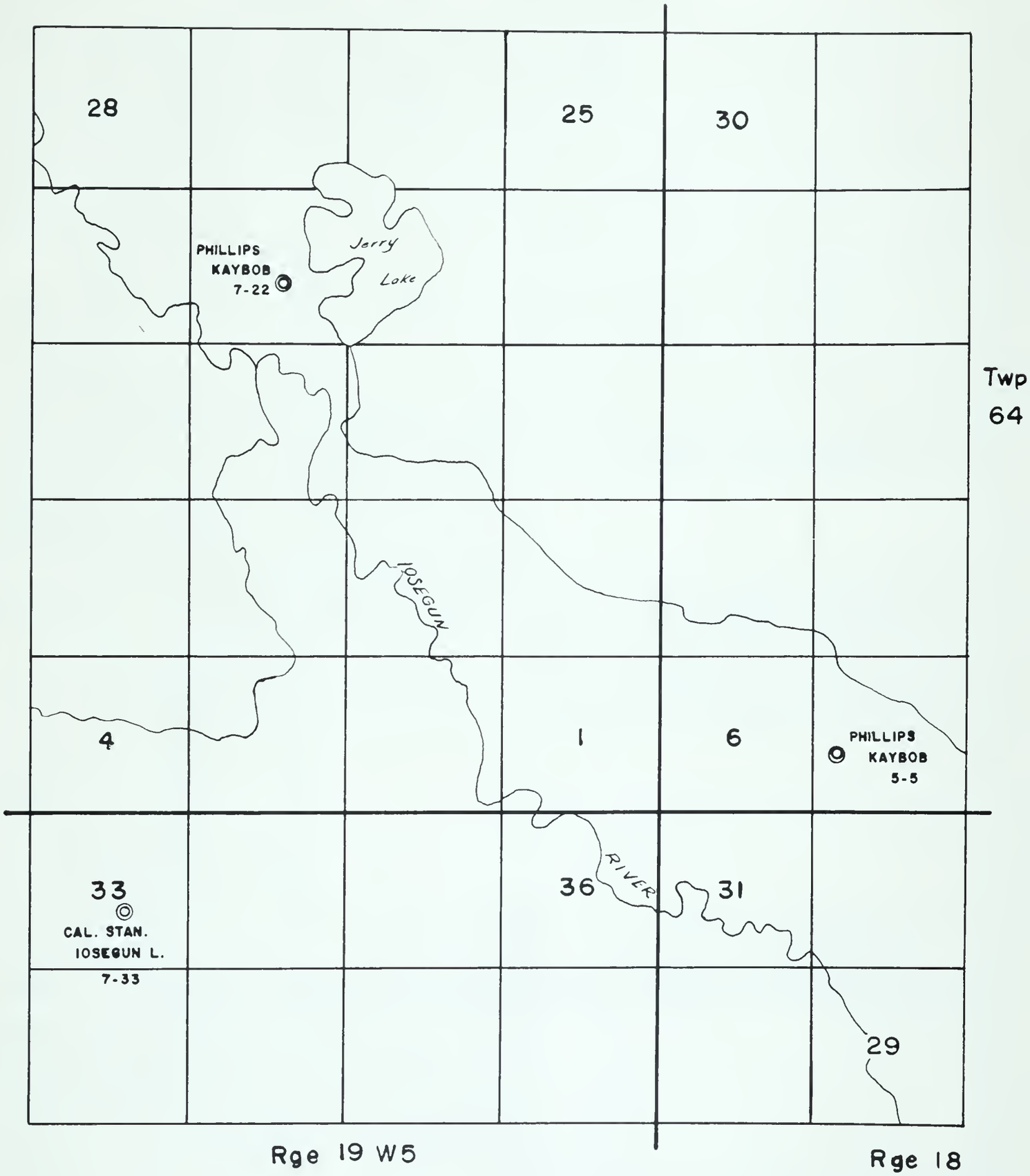
FIG. I.

INDEX MAP

ALBERTA

SCALE

0 50 MILES 100 150



KAYBOB AREA

FIG. 2.

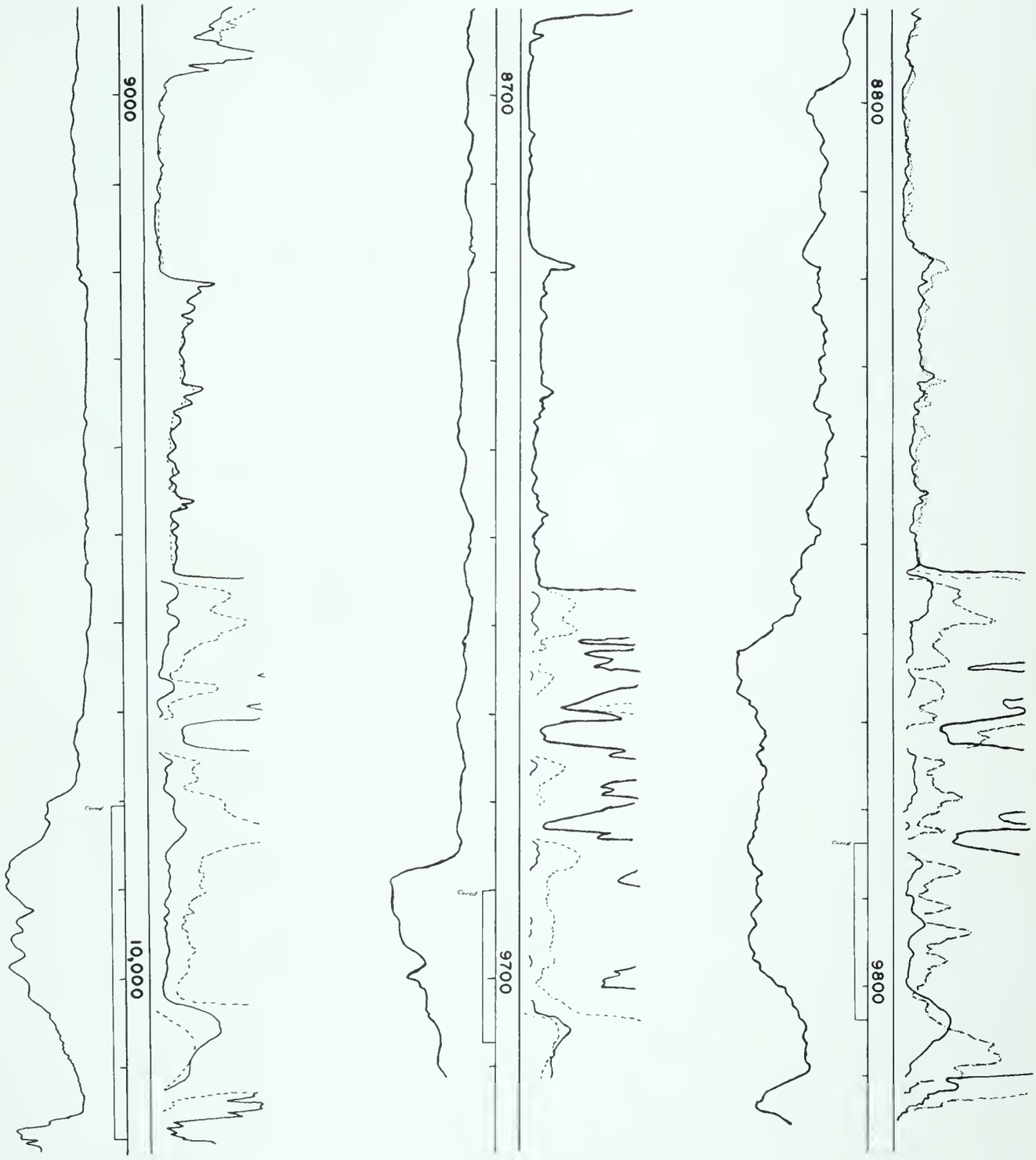
TABLE OF FORMATIONS

AGE	EDMONTON AREA	SWAN HILLS AREA	THICKNESS IN FEET	LITHOLOGY
TERTIARY		Un-named		Surface gravels
UPPER CRETACEOUS	Paskapoo	Paskapoo	2300	Continental and brackish water sandstones and shales with coal beds
	Edmonton - Belly River	Edmonton - Belly River		
	Lea Park	Lea Park	390	Dark grey shales
LOWER CRETACEOUS	Colorado	Colorado	1220	Grey and brown shales and mudstones
	Viking	Viking	110	Quartz and chert sandstones
	Joli Fou	Joli Fou	20	Dark grey shales
	Blairmore	Blairmore	690	Continental and brackish water sandstones and shales with coal beds.
	Quartz Sand Series	Quartz Sand Series	200	Quartzose sandstones
JURASSIC		Unconformity		
		Fernie	45	Dark grey and brown marine shales
TRIASSIC		Nordegg	110	Bituminous, calcareous shales
PERMIAN				
PENNSYLVANIAN	Unconformity	Unconformity		
MISSISSIPPIAN		Shunda	100	Light brown, argillaceous, silty limestone.
		Pekisko	180	Buff, fine crystalline, fragmental and crinoidal limestone
		Banff	630	Siltstones, grey, green, argillaceous limestones, and grey to brown shale
		Exshaw	15	Bituminous shale
	Wabamun	Wabamun	820	Light brown, dense limestones, with traces of anhydrite
DEVONIAN Upper	Graminia	Graminia	190	Light brown, silty dolomites, and medium crystalline dolomites
	Calmar	Shale Unit	1290	Green, calcareous shales with minor dense, argillaceous limestone beds; some bituminous shales
	Nisku			
	Ireton			
	Leduc Reef / Duvernay			
	Cooking Lake			
	Beaverhill Lake	Beaverhill Lake Reef / Beaverhill Lake	475	Interbedded green shales and light brown, argillaceous limestones; some bituminous shale
			60 - 475	Bioclastic and reef limestones
? Middle ?	Elk Point	Elk Point / Gilwood Sand	130 - 1100	Dark green and red shales with quartzose sandstones
SILURIAN	Unconformity	Unconformity		
ORDOVICIAN				
CAMBRIAN Upper				
Middle				
Lower	Cambrian	Cambrian	0-970	Red and green micaceous, glauconitic sands, shales and dolomites
	Unconformity	Unconformity		
PRECAMBRIAN				Crystalline, igneous and metamorphic rocks.

after Home (1958)

TABLE SHOWING STRATIGRAPHIC POSITION OF BEAVERHILL LAKE REEF

FIG. 3.



CAL. STAN. IOSEGUN
LAKE no. 7-33
Lsd 7-33-63-19 W5

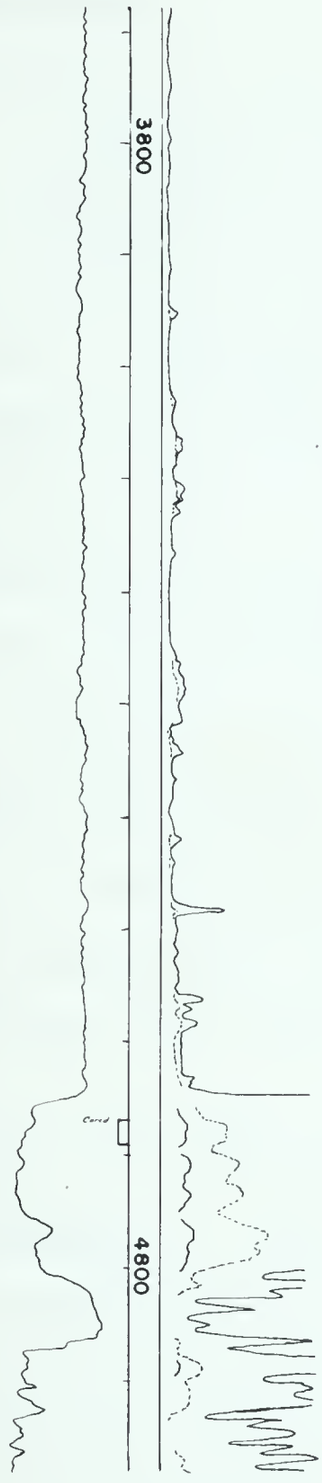
PHILLIPS KAYBOB
"A" no. 7-22
Lsd 7-22-64-19 W5

PHILLIPS KAYBOB
"B" no. 5-5
Lsd 5-5-64-18 W5

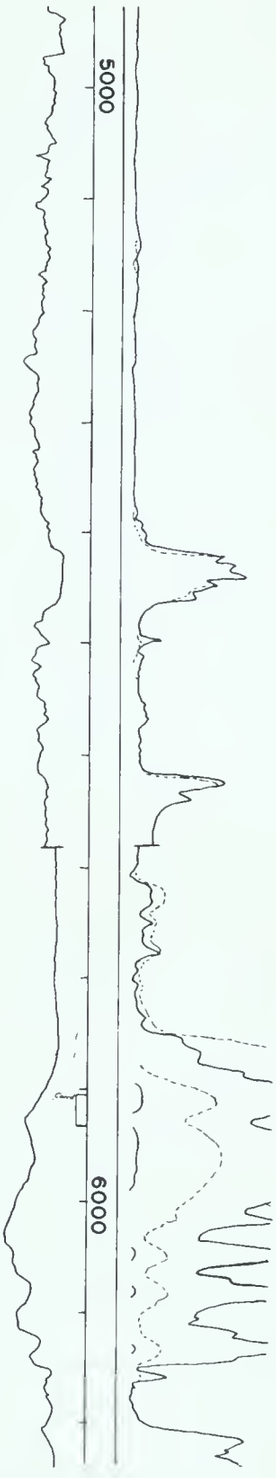
ELECTRIC LOGS OF SAMPLED WELLS SHOWING CORED INTERVALS,

KAYBOB AREA

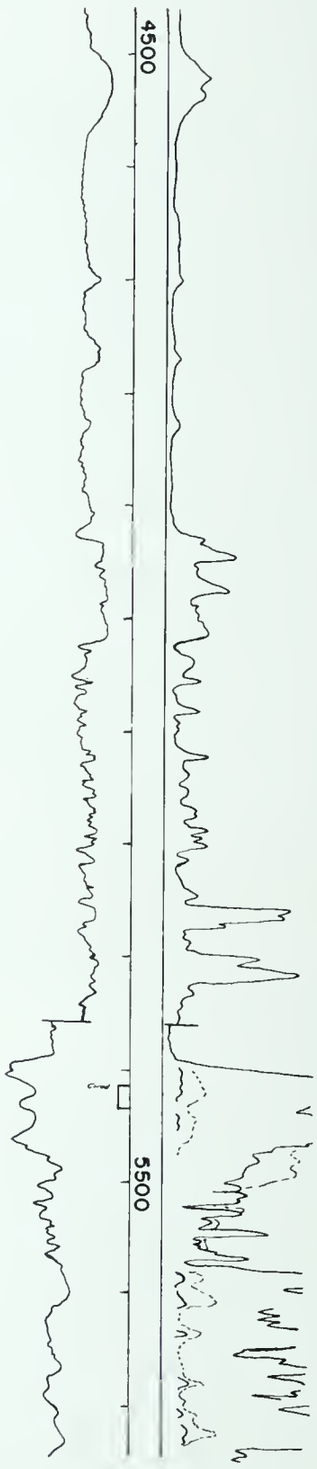
FIG. 4.



CDN. SEABOARD
HAY R. no. 2
Lsd 4-18-121-1 W6



CDN. SEABOARD
KEG R. no. 6-11
Lsd 6-11-101-4 W6



CDN. SEABOARD
N. CADOTTE no. 15-24
Lsd 15-24-90-15 W5

ELECTRIC LOGS OF SAMPLED WELLS SHOWING CORED INTERVALS NORTH,

PEACE RIVER AREA.

FIG. 5.

PALEOECOLOGY

Stromatoporoids are benthonic, sessile, marine organisms found mainly in biohermal or biostromal reef limestones and occasionally in calcareous shales. Many of these reefs consist of fragmented stromatoporoid colonies such as would be expected in a near surface environment subject to strong wave action or in fore-reef "talus" position. Some stromatoporoids have an encrusting nature and grow over each other or over other organisms. Seasonal variations can be noted by the character of the latilaminae. Thin latilaminae indicate poor growing conditions such as a poor carbonate supply, insufficient quantity of food or an influx of mud. Thick latilaminae, however, suggest ideal conditions in clear warm water with a plentiful food supply.

In the Kaybob reef the lower part consists of layers of Amphipora in a very argillaceous limestone. Above this is a transitional section of alternating beds of fragmental stromatoporoid material and shale or shaly limestone, all indicating an environment barely tolerant to stromatoporoid growth. The argillaceous portions represent influxes of mud which killed the stromatoporoids locally. When slightly favorable conditions again prevailed the stromatoporoids grew over this muddy base and were broken up by wave action as they grew. Above this transitional zone lies the main

reefal zone where conditions were at their best for healthy stromatoporoid growth. The latilaminae are thick and well developed and the colonies large but seldom intact, indicating turbulent waters that continually battered the rapidly growing colonies. Stromatoporoid growth was probably terminated by a change in temperature or lack of food rather than an inundation of mud since the limestone above is comparatively clean.

In short, there were first muddy conditions that gradually cleared until stromatoporoid growth was favored. Then a period of optimum conditions prevailed, followed by a change in temperature or a loss of food supply and, therefore, termination of reef building.

The ecologic relations of the Amphipora are difficult to assess, as these small coenostea have not been noted attached. They seem to be more widely distributed through different lithofacies than other stromatoporoids and the Amphipora tend to dominate the faunal record where stagnant bottom conditions would be implied by the highly bituminous and sulphurous nature of non-porous carbonates. Amphipora seem to be too widely tolerant to be useful as indicators of environment. The range in size might indicate temperature variations but this has not been established.

CHAPTER THREE

SYSTEMATIC PALEONTOLOGY

HISTORY OF THE STUDY OF STROMATOPOROIDS

The earliest European student of stromatoporoids was Baron von Rosen (1867) who referred to them as "horny sponges" that had become calcified. At about the same time in England, Nicholson (1873-75, 1879, 1886-87, 1889, 1891-92) began his work on stromatoporoids and completed one of the largest and most thorough investigations ever done on them. His work has been used as a basis by most subsequent workers. Nicholson concluded that stromatoporoids are coelenterates allied to the class Hydrozoa. He recognized two groups; the milleporoids or those having zooidal tubes and the hydractinoids without zooidal tubes. He was the first to realize the importance of using the interior structure as well as the external characteristics as a means of identification.

Heinrich (1916) rejected Nicholson's classification of the milleporoid and hydractinoid groups and formulated a classification based on character of tissue. He erected two families-- Actinostromidae with non-porous or compact fibres and Stromatoporidae with porous or perforate tissue. More recent studies by Lecompte (1952) in France and

Yavorsky (1955) in Russia are basically in agreement with Nicholson's classification.

Studies of North American stromatoporoids are not common. First reference to them was by Nicholson (1873) who described some from Ontario. Hall and Whitfield (1873) described five species and Winchell (1886) described four species. From this work right up until Parks' important work in the 1930's very little was done with North American stromatoporoids. Parks (1933) referred to the resemblance of stromatoporoids to certain Foraminifera and in 1936 still maintained that stromatoporoids had no affinity with the class Hydrozoa. In the same year he attempted a thorough and systematic description involving the maculate and compact tissue of the skeletal structure. However, the work was never completed for he died in 1936 shortly after the research began. Fritz and Waines (1956) of the University of Toronto described some stromatoporoids from the Upper Abitibi limestone but these are limited mainly to the genus Syringostroma.

The most recent and fundamental work on North American stromatoporoids was by Galloway and St. Jean at the University of Indiana. The senior author began the study in 1939 and a complete monograph covering eighteen years of research was published in 1957. Galloway retained Nicholson's concept

that stromatoporoids are of the class Hydrozoa but separated them into a stromatoporoid group and a sphaeractinoid group. He proposed that stromatoporoids were present only to the end of Devonian time whereas the sphaeractinoids first appeared in the Carboniferous. He rejected Parks' idea that stromatoporoids are related to the Foraminifera or sponges. His work will undoubtedly serve as a basis for subsequent studies which may show the value of stromatoporoids in correlation.

DIAGNOSTIC CHARACTERS OF FAMILIES OF STROMATOPOROIDEA

after Galloway (1957)

FAMILY I

LABECHIIDAE

Tissue compact and flocculent; skeleton composed of overlapping, convex plates, without or with pillars; coenosteum laminar, massive or columnar.

Genera: Cystostroma, Aulacera, Rosenella, Pseudostylodictyon, Sinodictyon, Cryptophragmus, Labechia, Labechiella, Pseudolabechia, Dermatostroma, Stromatocerium.

FAMILY 2

CLATHRODICTYIDAE

Tissue compact, fibrous or porous, not maculate; cysts side by side, or with laminae; pillars short; coenostea laminar or massive.

Genera: Clathrodictyon, Anostylostroma, Atelodictyon, Stictostroma, Stromatoporella.

FAMILY 3

ACTINOSTROMATIDAE

Tissue compact; fibrous or porous; laminae regular; pillars long, or regularly superposed.

Genera: Actinostroma, Gerronostroma, Trupetostroma, Lophiostroma.

FAMILY 4

IDIOSTROMATIDAE

Tissue compact, fibrous or porous, not maculate; coenosteum ramose, mostly with axial tube.

Genera: Clavidictyon, Paramphipora, Dendrostroma, Idiostroma, Stachyodes, Amphipora.

FAMILY 5

STROMATOPORIDAE

Tissue maculate; laminae and pillars fused; coen-

osteum laminar to massive.

Genera: Ferestromatopora, Stromatopora, Taleastroma, Syringostroma, Parallelopora, Hermatostroma, Clathrocoilona, Synthetostroma, Actinodictyon.

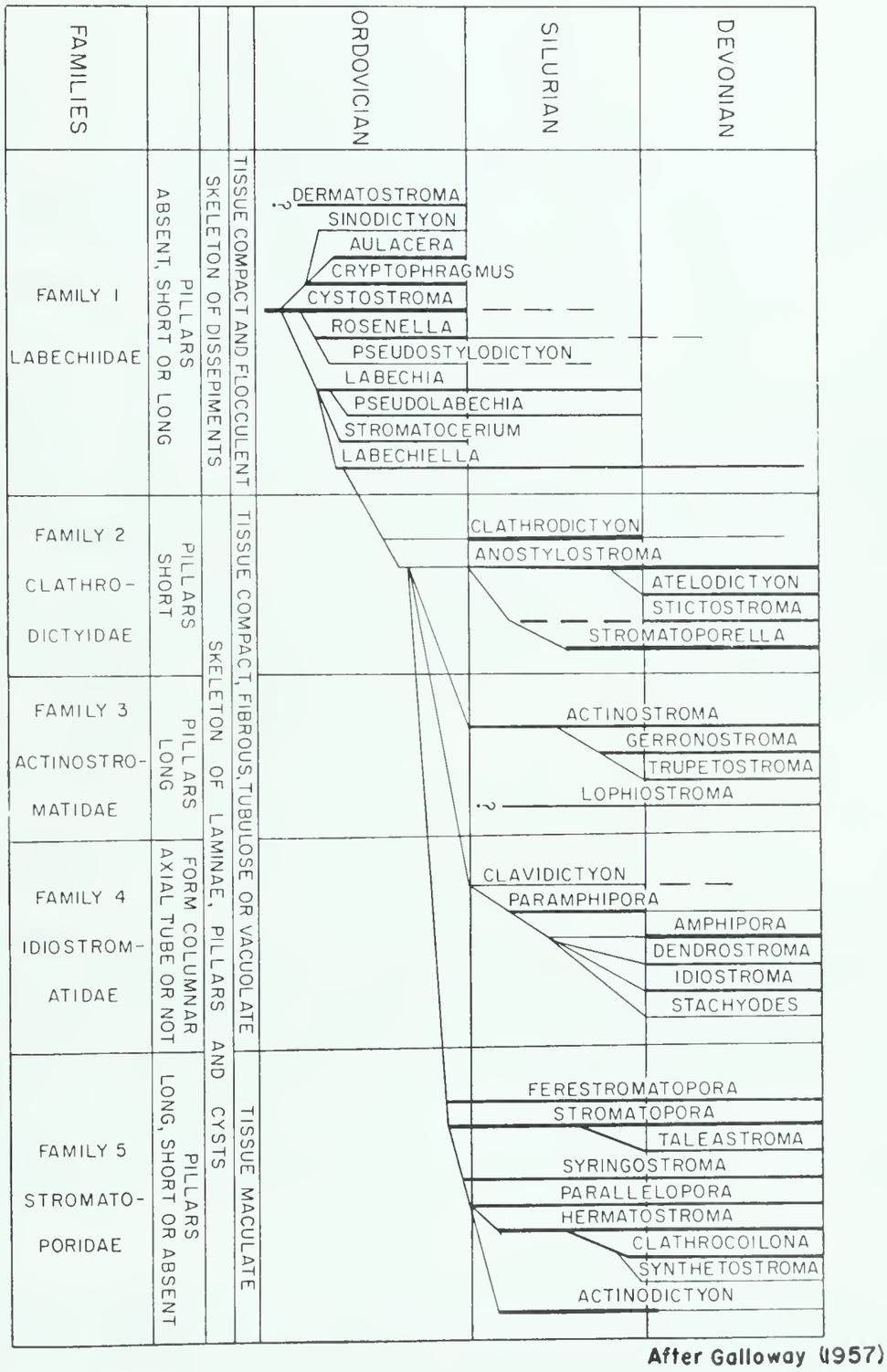

GEOLOGIC RANGES AND RELATIONSHIPS OF THE FAMILIES AND GENERA OF STROMATOPOROIDEA
FAMILIES
ORDOVICIAN
SILURIAN
DEVONIAN
SKELETON OF DISSEPIMENTS
SKELETON OF LAMINAE, PILLARS AND CYSTS
TISSUE COMPACT AND FLOCCULENT
TISSUE COMPACT, FIBROUS, TUBULOSE OR VACUOLATE
TISSUE MACULATE
FAMILY 1
LABECHIIDAE
PILLARS ABSENT, SHORT OR LONG
?DERMATOSTROMA
SINODICTYON
AULACERA
CRYPTOPHRAGMUS
CYSTOSTROMA
ROSENELLA
PSEUDOSTYLODICTYON
LABECHIA
PSEUDOLABECHIA
STROMATOCERIUM
LABECHIELLA
FAMILY 2
CLATHRO-
DICTYIDAE
PILLARS SHORT
CLATHRODICTYON
ANOSTYLOSTROMA
ATELODICTYON
STICTOSTROMA
STROMATOPORELLA
FAMILY 3
ACTINOSTRO-
MATIDAE
PILLARS LONG
ACTINOSTROMA
GERRONOSTROMA
TRUPETOSTROMA
?LOPHIOSTROMA
FAMILY 4
IDIOSTROM-
ATIDAE
FORM COLUMNAR AXIAL TUBE OR NOT
CLAVIDICTYON
PARAMPHIPORA
AMPHIPORA
DENDROSTROMA
IDIOSTROMA
STACHYODES
FAMILY 5
STROMATO-
PORIDAE
PILLARS LONG, SHORT OR ABSENT
FERESTROMATOPORA
STROMATOPORA
TALEASTROMA
SYRINGOSTROMA
PARALLELOPORA
HERMATOSTROMA
CLATHROCOILONA
SYNTHETOSTROMA
ACTINODICTYON
After Galloway (1957)

FIG. 6.

FORMAL DESCRIPTIONS

Phylum COELENTERATA

Class HYDROZOA Owen, 1843

Order STROMATOPOROIDEA Nicholson and Murie, 1878

Family ACTINOSTROMATIDAE Nicholson, 1886

The family Actinostromatidae is characterized by the following features: coenosteum massive or laminar, formed of well differentiated elements; laminae pronounced but usually not continuous; pillars strong and regularly superposed to form columns; skeletal tissue compact; astrorhizae may or may not be present.

Genus ACTINOSTROMA Nicholson, 1886

Coenostea massive or laminar; some latilaminate; composed of well defined laminae and pillars; pillars connected to each other by horizontal radial processes; skeletal tissue of pillars and laminae compact; astrorhizae present.

Specimens that cannot be identified with named species because of lack of references and/or poor preservation are designated with nomina aperta below as Actinostroma sp. A and Actinostroma sp. B. Size and shape of many of the coenostea discussed are not known since only fragmentary specimens were available.

TABLE I

Comparison of Beaverhill Lake specimens with *A. expansum* (Hall and Whitfield) taken from Parks (1936, p. 118) and *A. verrucosum* Goldfuss taken from Nicholson (1886, p. 134).

	Vertical section				Horizontal section	
	laminae		pillars		astrorhizal canals diameter (mm.)	mamelons height (mm.)
	no. in 2 mm.	thickness (mm.)	no. in 2 mm.	thickness (mm.)		
Actinostroma sp. A no. 9626	6-8	0.14-0.18	6-7	0.12-0.16	0.2-0.4	-
Actinostroma sp. B no. 9630	5-6	0.14-0.15	5-7	0.18-0.20	0.3-1.0	5.0
A. expansum (Hall and Whitfield)	10	?	6-10	0.17	?	?
A. verrucosum Goldfuss	10	0.06?	8	0.10?	?	5.0

Actinostroma sp. *A*

Plate 1, figures 1 and 2

OCCURRENCE: One specimen (figured type no. 9626), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9626 feet, northwestern Alberta.

DESCRIPTION: The following is based upon four sections (9626 a, b, e, g) of the figured type, a fairly well preserved coenosteum, encrusting a *Stromatopora*.

> Laminae distinct, vary from 0.14 mm. to 0.18 mm. in thickness with from 6 to 8 laminae in 2 mm.; pillars spool-shaped, superposed through 15 or more laminae; pillars vary from 6 to 7 pillars in 2 mm. and 0.12 to 0.16 mm. in diameter; radial processes surrounding pillars not well defined; tissue compact; astrorhizae abundant with canals varying from 0.2 mm. to 0.4 mm. in diameter; skeletal tissue represents approximately 60 percent of horizontal section.

DISCUSSION: *Actinostroma* sp. *A* resembles the Upper Devonian specimen of *A. expansum* (Hall and Whitfield) described by Parks 1936, p. 118, pl. XIII, figs. 3-4; pl. XIX, figs. 3-6, and illustrated by Galloway, 1957 pl. 31, fig. 9. Parks' measurements of the skeletal elements of *A. expansum* (Hall and Whitfield) show the pillars to be approximately 0.17

mm. in diameter and number 6 to 10 pillars in 2 mm. and 10 laminae in 2 mm. This compares favorably with the skeletal elements of Actinostroma sp. A. Since the specimen has indefinite radial processes, it was not identified as A. expansum.

Actinostroma sp. B

Plate 1, figures 3 and 4

OCCURRENCE: One specimen (figured type no. 9630), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9630 feet, northwestern Alberta.

DESCRIPTION: The following is based upon three sections (9630 a, b, d) of the figured type, a fairly well preserved coenosteum.

Laminae continuous and regularly spaced varying from 0.14 mm. to 0.15 mm. in thickness, numbering 5 to 6 laminae in 2 mm.; pillars spool-shaped and regularly superposed, thickness varys from 0.18 mm. to 0.20 mm. and pillars number 5 to 7 in 2 mm.; radial processes poorly defined; galleries prominent vertically since laminae are broken more often than pillars; skeletal tissue of pillars and laminae compact; astrorhizae abundant with canals varying from 0.3 mm. to 1.0 mm. in diameter; mamelons abundant,

vary from 7 mm. to 10 mm. in diameter and reach a maximum height of 5 mm.; astrorhizae frequently radiate from the mamelon centres; skeletal tissue represents 50 to 70 percent of horizontal section.

DISCUSSION: Actinostroma sp. B resembles Actinostroma sp. A in arrangement and size of skeletal elements, but differs in that mamelons are more common.

Family STROMATOPORIDAE Winchell, 1867

The following features are characteristic of the family Stromatoporidae: coenosteum massive to laminar, composed of latilaminae, laminae and both short and long pillars; galleries indefinite and sometimes filled with secondary tissue; both secondary and skeletal tissue maculate; pseudozooidal tubes common; astrorhizae and mamelons common.

Genus STROMATOPORA Goldfuss, 1826

Coenostea massive or laminar with latilaminae that are composed of discontinuous microlaminae; pillars narrow and indefinite, often consisting of secondary tissue thus making galleries small and irregular; tissue maculate; astrorhizae usually well developed; pseudozooidal tubes common.

Nicholson (1886, p. 91) interpreted the horizontal and vertical structure as being amalgamated so that pillars and laminae are obscure.

Species of Stromatopora are hard to recognize because of their poorly defined pillars and laminae and the large amount of secondary tissue. For this reason four groups of species have been outlined by Galloway and St. Jean (1957, p. 167) as follows:

Group 1. S. concentrica Goldfuss group. Interlaminar spaces largely filled with secondary, maculate tissue, obscuring laminae, pillars and galleries.

Group 2. S. hupschi (Bargatzky) group. Pseudozooidal tubes conspicuous to dominant over laminae and galleries.

Group 3. S. laminosa Lecompte group. Laminae dominant over pillars and pseudozooidal tubes.

Group 4. S. pachytexta Lecompte group. Laminae strong, coarsely maculate; pillars long, light-colored and dense, round in tangential section.

The groups are not considered distinct enough to warrant generic or subgeneric status, but do serve as a method of "keying" the species.

Specimens that cannot be identified with named species because of lack of references and/or poor preservation are designated nomina aperta below as Stromatopora sp. A, Stromatopora sp. B, Stromatopora sp. C, etc. Size and shape of many of the coenostea are not known since only fragmentary specimens were available.

TABLE 2

Comparison of Beaverhill Lake specimens with the holotype of S. mononensis Galloway and St. Jean (1957, p. 178) and S. divergens Galloway and St. Jean (1957, p. 173).

	Vertical section					Horizontal section	
	lati-laminae thick-ness (mm.)	lam-inae in 2 mm.	pil-lars in 2 mm.	pseudo-zooidal tubes		astror-hizal canals dia-meter (mm.)	mam-elons height (mm.)
				length (mm.)	dia-meter (mm.)		
S. mononensis holotype	-	16-18	4	-	0.7	0.1	1-2
hypotype no. 5907	-	16-20	-	0.9	0.2-0.6	0.3-0.5	2.5
Stromatopora sp. A no. 9626	-	-	5-6	0.9-1.4	0.3-0.7	0.3	-
Stromatopora sp. B no. 9614	-	-	7-8	0.5-0.7	0.5-1.0	0.5-0.8	-
Stromatopora sp. C no. 9622	indist-inct	-	-	0.5-1.1	0.4	0.7-1.0	-
Stromatopora sp. D no. 9627	3-5	-	-	0.8-1.6	0.3-1.7	0.6-0.9	-
Stromatopora sp. E no. 9785	vari-able	12-16	6-7	inf-inite	0.1-0.2	0.5-0.7	-
S. divergens Galloway and St. Jean	-	6-7	6	inf-inite	0.09	0.1	2-3

Stromatopora mononensis Galloway and St. Jean

Plate 2, figures 3 and 4

Stromatopora mononensis Galloway and St. Jean, 1957, Bull. Am. Paleont., Vol. 37, No. 162, p. 178, 179.

OCCURRENCE: One specimen (hypotype no. 5907) Slave Point (?) formation, Seaboard Keg River no. 6-11, Lsd. 6, Sec. 11, Tp. 101, R. 4, W. 6th Mer., depth 5907 feet, northern Alberta.

DESCRIPTION: The following is based upon one section (5907 a) of the hypotype, which cuts both vertically and horizontally through a well preserved coenosteum.

Laminae appear as fine, dark, closely spaced lines which occasionally touch, numbering 16 to 20 laminae in 2 mm.; latilaminae vague and approximately 1.0 mm. in thickness; pillars indefinite and cannot be distinguished from infilling tissue; galleries round, oval or vermicular, distinct in horizontal section and smaller and more sinuous than astrorhizal canals; pseudozooidal tubes common, long, narrow and tabulate, varying from 0.8 mm. to 1.0 mm. in length and from 0.2 mm. to 0.6 mm. in diameter; tissue distinctly maculate; maculae best observed in horizontal section; astrorhizal canals abundant, varying from 0.3 mm. to 0.5 mm. in dia-

meter; section cuts vertically through one mamelon 2.5 mm. in height; skeletal tissue represents approximately 80 percent of horizontal section.

DISCUSSION: The hypotype resembles the holotype closely in internal structure. However, the height and diameter of the hypotype are not known and the one mamelon measured may not be representative.

Stromatopora sp. A (ex. gr. S. hupschi
Galloway and St. Jean, 1957)
Plate 3, figures 2 and 3

OCCURRENCE: One specimen (figured type no. 9626), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9626 feet, northwestern Alberta.

DESCRIPTION: The following is based upon three sections (9626 a, b, f) of the figured type, a fairly well preserved coenosteum, encrusted by an Actinostroma.

Laminae discontinuous, irregular and hard to distinguish from pillars; latilaminae vaguely outlined by oil staining, composed of microlaminae which have a random arrangement leaving irregular galleries; pillars, 5 to 6 in 2 mm., only distinguishable when superposed to form columns; oval or round,

tabulate pseudozooidal tubes, the most prominent feature of the specimen, vary from 0.3 mm. to 0.7 mm. in diameter and from 0.9 mm. to 1.4 mm. in length, distinguished from larger galleries by dark surrounding rims; tissue of pillars and laminae maculate; astrorhizae not common; skeletal tissue represents approximately 80 percent of horizontal section.

DISCUSSION: Stromatopora sp. A has pseudozooidal tubes dominant over laminae and pillars and is therefore typical of the S. hupschi group, but differs from S. hupschi in that it has longer and more continuous pseudozooidal tubes.

Stromatopora sp. B (ex. gr. S. hupschi
Galloway and St. Jean, 1957)
Plate 1, figures 5 and 6

OCCURRENCE: One specimen (figured type no. 9614), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9614 feet, northwestern Alberta.

DESCRIPTION: The following is based upon three sections (9614 a, b, c) of the figured type, a poorly preserved coenosteum.

Laminae discontinuous, irregular and hard to distinguish from pillars; latilaminae not present; pillars

only slightly more prominent than laminae, varying from 7 to 8 pillars in 2 mm., usually superposed; galleries irregular because of indefinite skeletal elements; pseudozooidal tubes, 0.5 mm. to 0.7 mm. in length and 0.5 mm. to 1.0 mm. in diameter, curved, circular or oval in horizontal section and round and tabulate in vertical section, distinguished from galleries and astrorhizal canals by dark surrounding rims; tissue of skeletal elements distinctly maculate; astrorhizal canals, approximately 0.7 mm. in diameter, abundant.

DISCUSSION: Stromatopora sp. B differs from Stromatopora sp. A in that pseudozooidal tubes are less common, less tabulate and shorter. Pillars are more prominent and astrorhizae more common. Although pseudozooidal tubes are not common the predominance of pseudozooidal tubes over pillars and laminae suggests that this species should be placed in the S. hupschi group.

Stromatopora sp. C (ex. gr. S. hupschi
Galloway and St. Jean, 1957)
Plate 3, figures 4 and 5

OCCURRENCE: One specimen (figured type no. 9622), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no.

7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9622 feet, northwestern Alberta.

DESCRIPTION: The following is based upon two sections (9622 a, c) of the figured type, a fairly well preserved coenosteum.

> Laminae not distinguished from pillars; latilaminae present but indistinct; pillars poorly defined, merge with laminae to form an irregular network; tabulate pseudozooidal tubes, 0.5 mm. to 1.1 mm. in length and 0.4 mm. to 0.7 mm. in diameter, flat, curved or round in horizontal section; tissue of laminae and pillars distinctly maculate; astrorhizal canals very abundant, varying from 0.7 mm. to 1.0 mm. in diameter.

DISCUSSION: Stromatopora sp. C is similar to Stromatopora sp. B in the number and type of pseudozooidal tubes. It differs from that species and also Stromatopora sp. A in that astrorhizae are more abundant and definite pillars are lacking. Since pseudozooidal tubes are still predominant over the laminae and pillars Stromatopora sp. C is probably in the S. hupschi group.

Stromatopora sp. D

Plate 3, figure 1

OCCURRENCE: One specimen (figured type no. 9627), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9627 feet, northwestern Alberta.

DESCRIPTION: The following is based upon one vertical section (9627 a) of the figured type, a fairly well preserved coenosteum.

Laminae not distinguished from pillars; latilaminae, well outlined by oil staining, vary from 3.0 mm. to 5.0 mm.; pillars indefinite; pseudozooidal tubes vary from 1.0 mm. to 1.6 mm. in length and 0.3 mm. to 1.7 mm. in diameter; tissue of pillars and laminae vaguely maculate; astrorhizal canals abundant, varying from 0.6 mm. to 0.9 mm. in diameter.

DISCUSSION: Stromatopora sp. D is similar in vertical section to Stromatopora sp. C. However, there is no horizontal section since only a small fragment of the specimen was available. Therefore, a complete comparison cannot be made.

Stromatopora sp. E

Plate 2, figures 1 and 2

OCCURRENCE: One specimen (figured type no. 9785), Beaverhill Lake formation, producing member, Phillips Kaybob "B" no.

5-5, Lsd. 5, Sec. 5, Tp. 64, R. 18, W. 5th Mer., depth 9785 feet, northwestern Alberta.

DESCRIPTION: The following is based upon three sections (9785 a, b, c) of the figured type, a fairly well preserved coenosteum.

> Laminae thin and convex upward in pseudozooidal tubes, numbering 12 to 16 laminae in 2 mm. and approximately 0.05 mm. in thickness; latilaminae common, undulating and vary greatly in thickness; pillars thick and regularly superposed forming long columns, varying from 6 to 7 in 2 mm. and from 0.16 mm. to 0.20 mm. in diameter; pseudozooidal tubes long, narrow and regularly traversed by convex upward laminae, varying from 0.1 mm. to 0.2 mm. in diameter; tissue of pillars and laminae finely maculate; astrorhizal canals common, varying from 0.5 mm. to 0.7 mm. in diameter.

DISCUSSION: The horizontal skeletal elements of Stromatopora sp. E are relatively thin, so could represent either laminae or tabulae. However, they are continuous from one pseudozooidal tube to another, therefore, must be termed laminae. Stromatopora sp. E has a very definite pillar system and since no species or group has pillars as the predominant feature this specimen was designated Stroma-

topora sp. E.

Family IDIOSTROMATIDAE Nicholson, 1886

The family Idiostromatidae possesses the following characteristics: coenosteum cylindrical and dendroid with branches that usually have axial tubes; pseudozooidal tubes may or may not be present; laminae thick and pillars irregular; skeletal tissue transversely fibrous; astrorhizae absent.

Genus STACHYODES Bargatzky, 1881

Coenostea dendroid with tabulate axial tubes; laminae thick and rest on each other, thus eliminating interlaminar spaces, thin dark lines mark the contact of one laminae with another; pillars rare and indefinite; pseudozooidal tubes traverse the laminae and branch near surface of coenostea; minute tubules parallel to pseudozooidal tubes; astrorhizae absent.

Specimens that cannot be identified with named species because of lack of references and/or poor preservation are designated with nomina aperta below as Stachyodes sp. A, Stachyodes sp. B, Stachyodes sp. C.

TABLE 3

Comparison of Beaverhill Lake specimens with *Stachyodes verticillata* (McCoy) taken from illustrations by Nicholson (1886, Pl. VIII, figs. 9-14).

	length (mm.)	diameter (mm.)	laminae and pillars thickness (mm.)	pseudozooidal tubes		axial tube diameter (mm.)
				length (mm.)	diameter (mm.)	
Stachyodes sp. A no. 9632	16.5	2.2-6.2	0.5-0.8	1.0-1.5	0.1-0.4	-
Stachyodes sp. B no. 9641	?	5.8-9.2	0.3-0.5	0.5-1.3	0.1-0.4	-
Stachyodes sp. C no. 9700	30	4.0-5.0	0.2-0.5	0.4-1.7	0.1-0.4	0.4-0.5
Stachyodes verticillata (McCoy)	?	9.0-11.0	?	1.0-2.0	0.5-1.0	0.5-0.6

Stachyodes sp. *A*

Plate 4, figures 4 and 5

OCCURRENCE: One specimen (figured type no. 9632) Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9632 feet, northwestern Alberta.

DESCRIPTION: The following is based upon one section (9632 a) of the figured type that cuts two well preserved coenostea vertically and one poorly preserved coenosteum horizontally.

> Coenosteum varies from 2.2 mm. to 6.2 mm. in diameter and is 16.5 mm. in length; laminae vary from 0.5 mm. to 0.8 mm. in thickness, separated by fine dark lines leaving no room for pillars or galleries; tabulate pseudozooidal tubes, varying from 1.0 mm. to 1.5 mm. in length and 0.1 mm. to 0.4 mm. in diameter, branch and become more abundant near surface of coenosteum; tissue of laminae transversely porous; astrorhizae absent.

DISCUSSION: *Stachyodes* sp. *A* resembles the specimen of *S verticillata* (McCoy) illustrated by Nicholson (1886, Pl. VIII, figs. 9-14) and illustrated by Galloway (1957, pl. 34, fig. 10). Measurements of the specimen taken by the writer from the illustrations show the coenosteum to be approx-

imately between 9 mm. and 11 mm. in diameter and with pseudozooidal tubes varying from 1.0 mm. to 2.0 mm. in length and from 0.5 mm. to 1.0 mm. in diameter. This, however, is somewhat larger than the figured type. Therefore, Stachyodes sp. A was not identified as S. verticillata.

Stachyodes sp. B

Plate 4, figure 3

OCCURRENCE: One specimen (figured type no. 9641), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9641 feet, northwestern Alberta.

DESCRIPTION: The following is based upon one section (9641 a) of the figured type that cuts one well preserved coenosteum horizontally.

Coenosteum varies from 5.8 mm. to 9.2 mm. in diameter; laminae varying from 0.3 mm. to 0.5 mm. in thickness, separated by fine dark lines thus leaving no room for pillars or galleries; tabulate pseudozooidal tubes long, thin and dendroid, or short and oval, varying from 0.1 mm. to 0.4 mm. in diameter and from 0.5 mm. to 1.3 mm. in length, branch and become more numerous near surface of coenosteum; tissue of laminae transversely porous; astrorhizae absent.

DISCUSSION: Stachyodes sp. B resembles Stachyodes sp. A in that the coenosteum and pseudozooidal tubes are of the same shape. However, it differs in that the coenosteum is somewhat larger in cross section. Stachyodes sp. B differs from the specimen of S. verticillata (McCoy) illustrated by Nicholson (1886, Pl. VIII, figs. 9-14) in that the coenosteum is smaller and the pseudozooidal tubes appear to have more tabulae.

Stachyodes sp. C

Plate 4, figures 1 and 2

OCCURRENCE: One specimen (figured type no. 9700), Beaverhill Lake formation, producing member, Phillips Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., depth 9700 feet, northwestern Alberta.

DESCRIPTION: The following is based upon one section (9700 a) of the figured type that cuts one well preserved coenosteum vertically.

Coenosteum varies from 4 mm. to 5 mm. in diameter and 30 mm. in length with three branches varying from 3 mm. to 4 mm. in diameter and from 8 mm. to 10 mm. in length; small axial tubes vary from 0.4 mm. to 0.5 mm. in diameter; laminae varying from 0.2 mm. to 0.5 mm. in thickness, separated by very fine dark lines; galleries small, poorly defined;

pillars indefinite; tabulate pseudozooidal tubes abundant near centre of coenosteum, vary from short and wide to long and vermicular, length varys from 0.4 mm. to 1.7 mm. and diameter varys from 0.1 mm. to 0.4 mm.; tissue of laminae transversely porous; astrorhizae absent.

DISCUSSION: Stachyodes sp. C resembles Stachyodes sp. A, Stachyodes sp. B and S. verticillata in that tissue is transversely porous and pseudozooidal tubes are equally tabulate. However, it differs in having an axial tube, a smaller coenosteum with several branches and less branching pseudozooidal tubes near the surface of the coenosteum.

Genus AMPHIPORA Schulz, 1883

Coenostea consist of slender, vermicular stems which may branch; axial tubes large and variable; large vesicles near surface of coenostea; both tube and vesicles may have tabulae; skeleton composed of both pillars and laminae; tissue transversely fibrous with dark median line; astrorhizae absent.

TABLE 4

Comparison of Beaverhill Lake specimens with Amphipora ramosa (Phillips) taken from Galloway and St. Jean (1957, p. 233).

Well no.	coen-osteum no.	Coenostea diameter (mm.)	Axial tubes diameter (mm.)	Comparative size of marginal vesicles
Kaybob "A" no. 7-22, Lsd. 7, Sec. 22, Tp. 64, R. 19, W. 5th Mer., 9708 feet	1	5.0	1.0	none
	2	3.0	1.0	medium
	3	2.0	-	large
	4	3.2	0.8	medium
	5	3.2	-	none
	6	3.1	1.0	small
	7	3.0	0.8	medium
	8	2.5	0.7	medium
Avg.		3.1	0.9	
Kaybob "B" no. 5-5, Lsd. 5, Sec. 5, Tp. 64, R. 18, W. 5th Mer., 9788 feet	1	2.2	-	medium
	2	2.8	0.7	none
	3	1.4	-	none
	4	2.5	-	none
	5	2.1	-	none
	6	2.6	-	none
	7	2.8	0.8	none
	8	4.0	-	none
Avg.		2.6	0.75	
Canadian Seaboard Cadotte no. 15-24 Lsd. 15, Sec. 24, Tp. 90, R. 15, W. 5th Mer., 5415 feet	1	3.1	0.8	none
	2	2.6	0.8	none
	3	2.6	-	large
	4	2.1	-	very large
	5	2.5	0.4	large
	6	3.3	?	large
	7	1.6	-	large
	8	2.7	0.7	large
	9	2.2	-	very large
	10	3.0	0.9	none
	11	2.1	0.9	very large
Avg.		2.5	0.75	

Well no.	coen-osteum no.	Coenostea diameter (mm.)	Axial tubes diameter (mm.)	Comparative size of marginal vesicles
Canadian	1	2.4	0.6	large
Seaboard	2	3.1	-	large
Cadotte	3	3.5	-	large
no. 15-24	4	3.0	-	large
Lsd. 15,	5	3.1	-	medium
Sec. 24,	6	3.0	1.0	none
Tp. 90,	7	2.9	1.0	large
R. 15, W.	8	3.1	-	none
5th Mer.,	9	3.2	-	large
5424 feet	10	3.0	-	none
	11	3.0	1.0	large
	12	3.4	-	large
Avg.		3.6	0.9	
California	1	3.2	1.0	large
Standard	2	3.0	1.0	large
no. 7-33	3	3.2	1.1	large
Lsd. 7,	4	3.2	0.8	none
Sec. 33,	5	4.0	1.1	medium
Tp. 63,	6	3.0	1.0	none
R. 19, W.	7	2.4	0.4	medium
5th Mer.,	8	2.2	0.5	none
9897 feet				
Avg.		3.25	0.86	
California	1	3.7	0.8	large
Standard	2	2.2	0.7	large
no. 7-33	3	2.6	0.9	none
Lsd. 7,	4	4.0	0.6	large
Sec. 33,	5	3.0	1.0	large
Tp. 63,	6	4.2	1.1	large
R. 19, W.	7	3.8	0.8	large
5th Mer.,	8	3.2	0.7	large
9902 feet	9	3.2	1.0	large
	10	3.2	0.9	medium
	11	3.1	0.7	large
Avg.		3.3	0.84	

Well no.	coen-osteum no.	Coenostea diameter (mm.)	Axial tubes diameter (mm.)	Comparative size of marginal vesicles
California Standard no. 7-33 Lsd. 7, Sec. 33, Tp. 63, R. 19, W. 5th Mer., 9905 feet	1 2 3	3.0 3.2 2.8	1.0 0.8 0.8	large large large
Avg.		3.0	0.87	
California Standard no. 7-33 Lsd. 7, Sec. 33, Tp. 63, R. 19, W. 5th Mer., 9908 feet	1 2 3	2.3 4.0 4.0	0.5 0.8 0.9	large medium large
Avg.		3.4	0.73	
Amphipora ramosa (Phillips)		1-4	0.2-0.6	large

Amphipora sp. A

Plate 5, figures 1 to 6

OCCURRENCE: One specimen (figured type no. 9902 and additional figured types 9708, 9788, 5415, 5424, 9897, 9905, 9908) from the Beaverhill Lake and Slave Point (?) formations, northwestern Alberta. The well locations are listed in Table 4.

DESCRIPTION: The following is based upon two sections of the

figured type (9902 b, c) and eight additional figured types listed in Table 4 most of which are well preserved coenostea.

> Coenostea, vermicular and non-branching, averaging 3.1 mm. in diameter; axial tube, averaging 0.83 mm. in diameter; occasionally lined with thin layer of fibrous tissue approximately 0.5 mm. thick; pillars and laminae equal in size vary from 0.15 mm. to 0.25 mm. in thickness with from 5 to 7 laminae in 2 mm. and from 5 to 7 pillars in 2 mm.; laminae highly arched and more continuous than pillars which diverge to outer edge of coenosteum; tissue of pillars and laminae transversely fibrous with dark median line from which fibres extend perpendicularly on either side; ring of large oval galleries near surface of coenosteum common; a peripheral lamina approximately one-half the thickness of interior laminae encloses coenosteum.

DISCUSSION: The figured type (9902), the best preserved specimen collected, is very close to Amphipora ramosa (Phillips) described by Galloway and St. Jean (1957, p. 233-236, pl. 23, figs. 2-6) except that the axial canal is somewhat larger. Therefore, the specimen was designated Amphipora sp. A. The arching of the laminae and diverging of the pillars (Pl. 5, fig. 3) is only apparent in oblique sections.

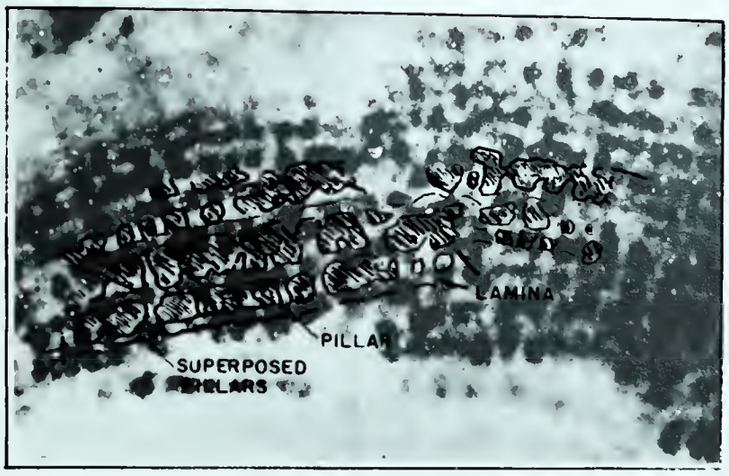
Tangential, axial and cross sections show only a random arrangement of the skeletal tissue. Occasional cross sections show no axial tube, this is because the section was cut near the end of the coenosteum and the axial tube had already terminated.

EXPLANATION OF PLATE 1

Figs. 1, 2--*Actinostroma* sp. *A*, from Phillips Kaybob "A" no. 7-22; 1, type no. 9626 g, vertical section, X 4, with pillars and laminae distinct and pillars superposed; 2, type no. 9626 a, horizontal section, X 9, with light areas representing galleries and dark areas cut ends of pillars which have indistinct radial processes. (p. 25)

Figs. 3, 4--*Actinostroma* sp. *B*, from Phillips Kaybob "A" no. 7-22; 3, type no. 9630 d, vertical section, X 15, showing indistinct pillars and laminae with pillars spool-shaped; light areas are galleries; 4, type no. 9630 a, horizontal section, X 4, with pillars and laminae obliquely revealed in cut ends of mamelons; some astrorhizal canals show a branching effect. (p. 26)

Figs. 5, 6--*Stromatopora* sp. *B*, from Phillips Kaybob "A" no. 7-22; 5, type no. 9614 c, vertical section, X 9, showing indefinite laminae and a pseudozooidal tube; 6, type no. 9614 b, horizontal section, X 6, taken below centre of an astrorhizal system which shows canals radiating from a common centre. (p. 33)



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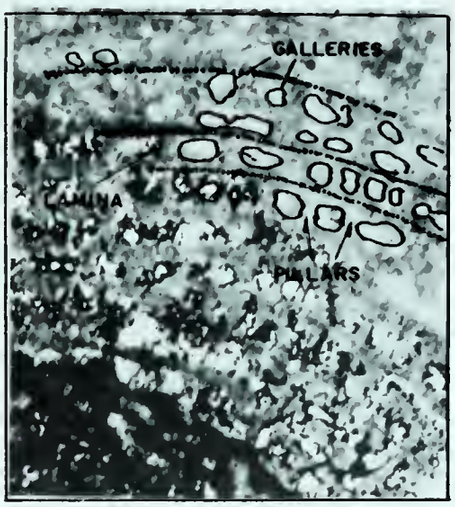
2.



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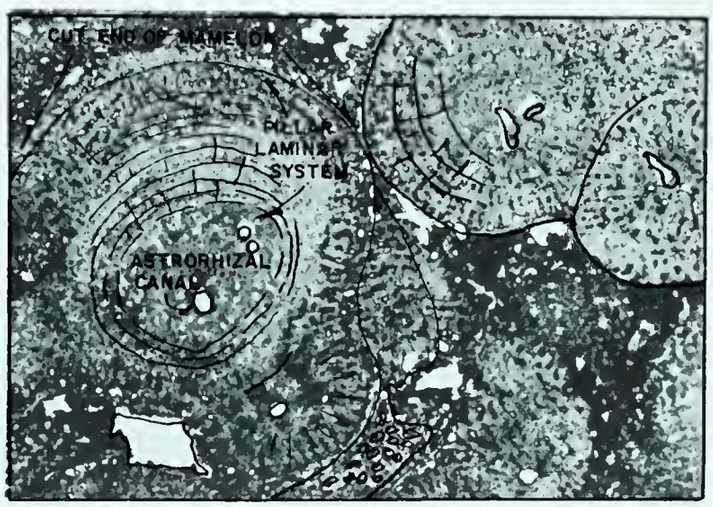

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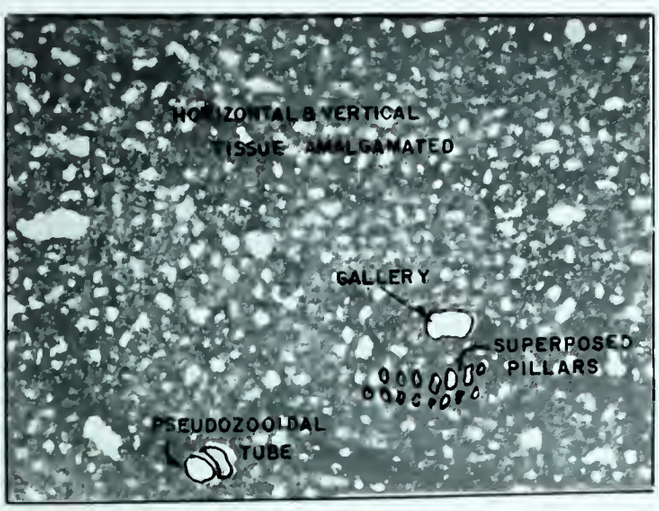

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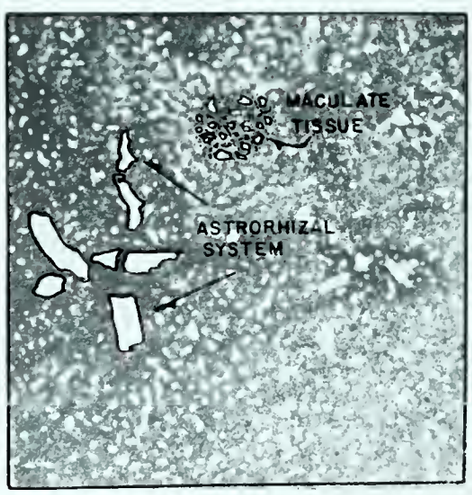
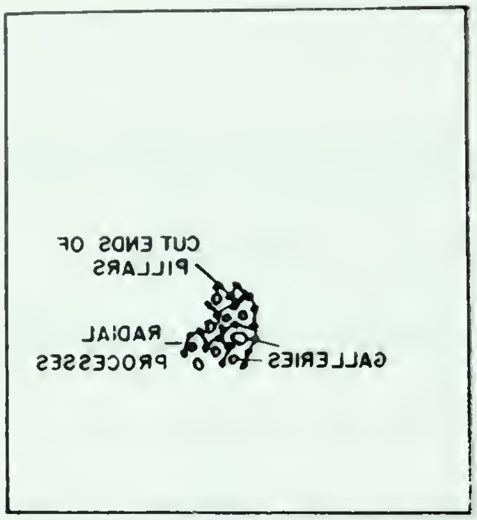
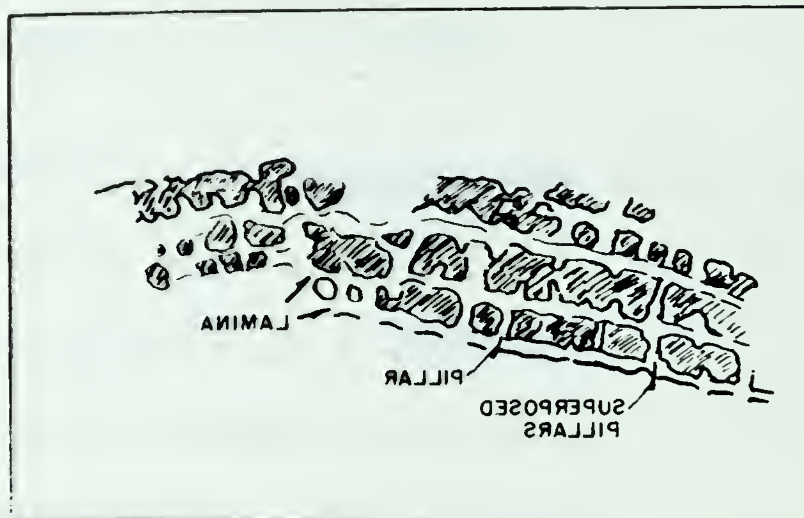
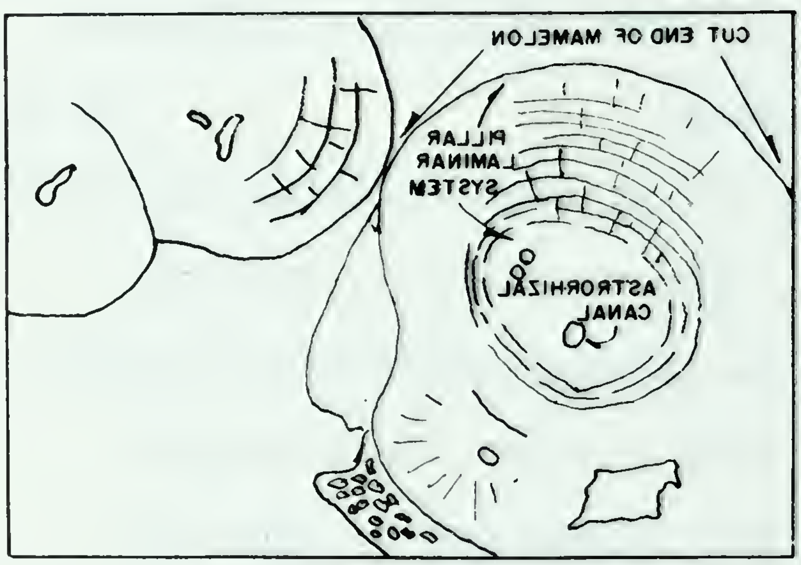


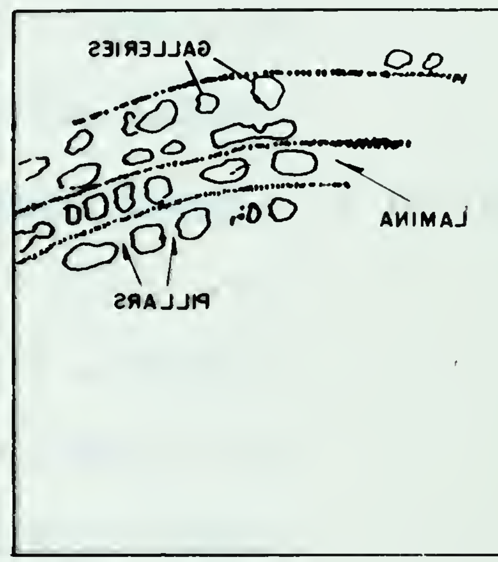
6.

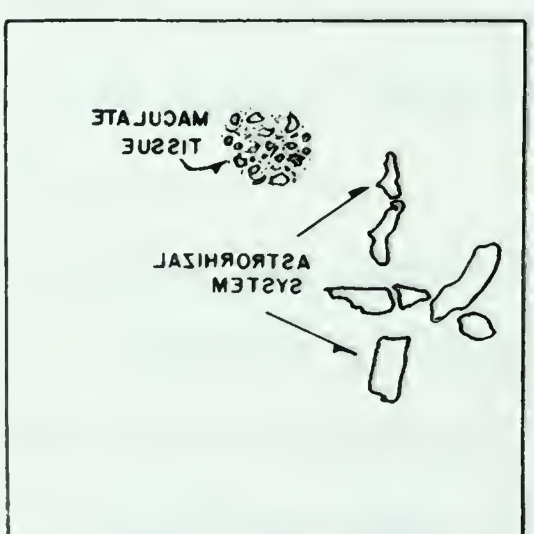
PLATE I

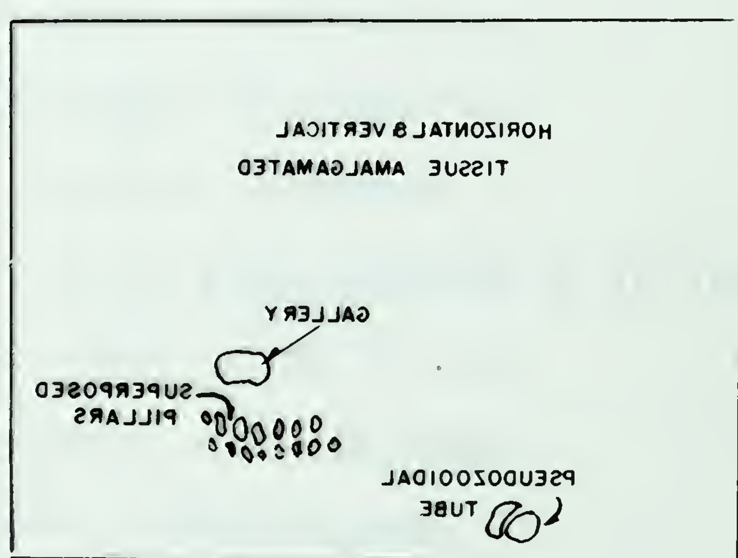

CUT ENDS OF PILLARS
RADIAL PROCESSES
GALLERIES

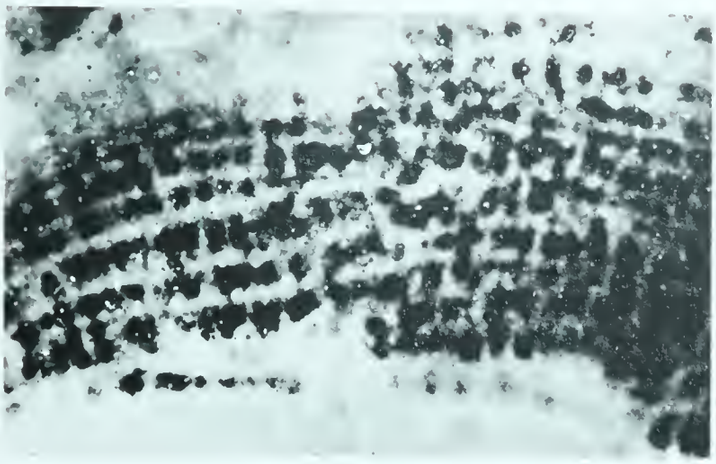

LAMINA
PILLAR
SUPERPOSED PILLARS


CUT END OF MAMELON
PILLAR
LAMINAR SYSTEM
ASTRORHIZAL CANAL


GALLERIES
LAMINA
PILLARS


MACULATE TISSUE
ASTRORHIZAL SYSTEM


HORIZONTAL & VERTICAL TISSUE AMALGAMATED
GALLERY
SUPERPOSED PILLARS
PSEUDOZOOIDAL TUBE



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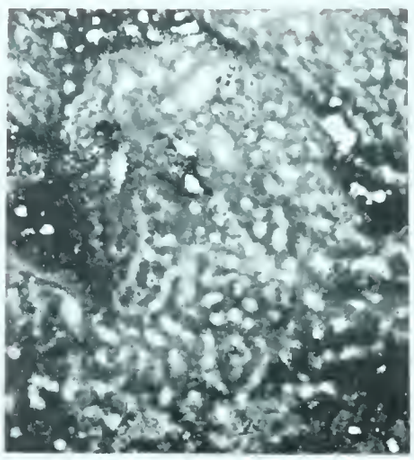

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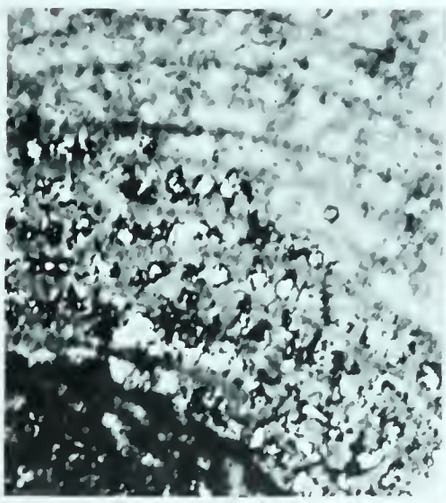

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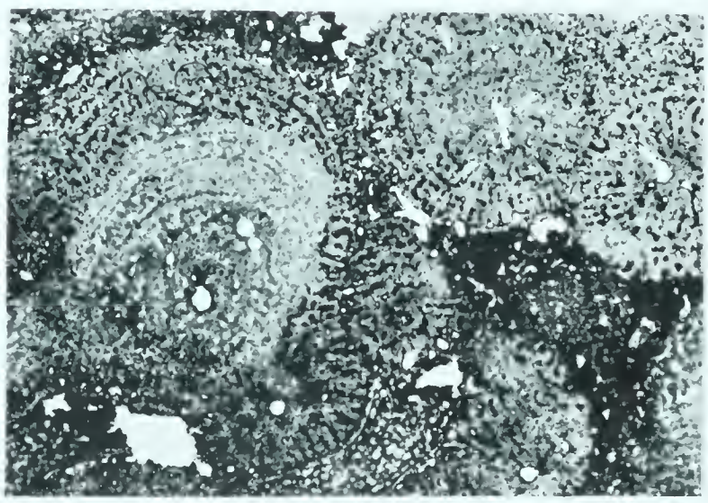

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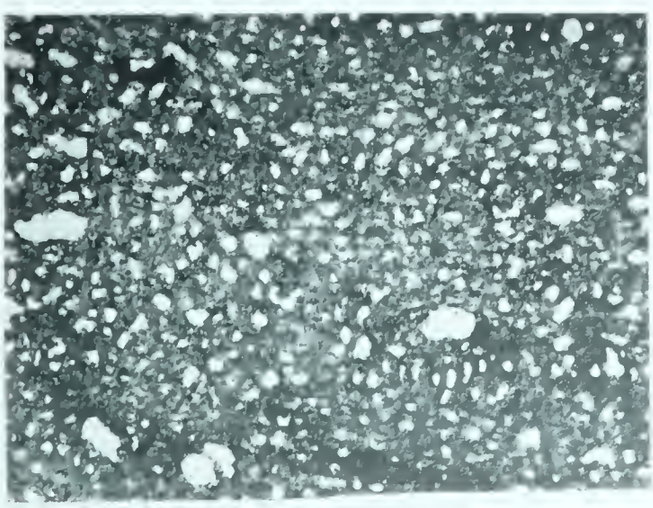

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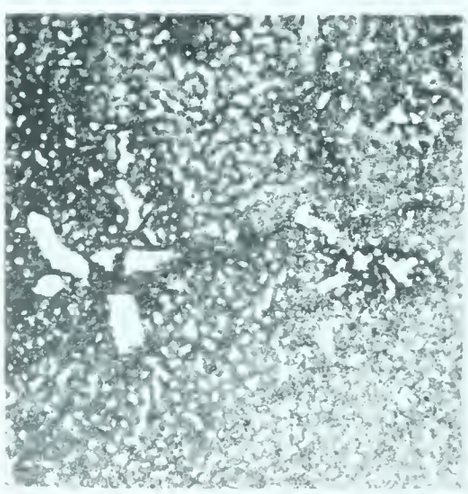


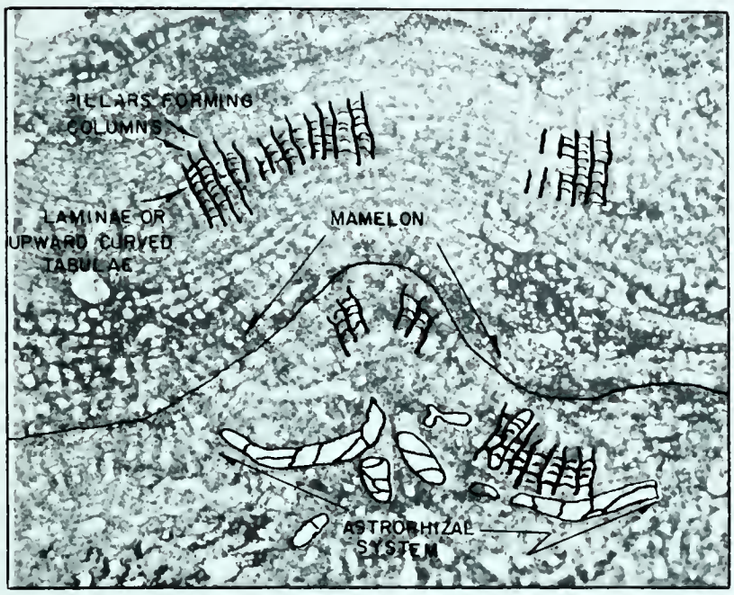
6.

PLATE I

EXPLANATION OF PLATE 2

Figs. 1, 2--*Stromatopora* sp. E, from Phillips Kaybob "B" no. 5-5; 1, type no. 9785 b, vertical section, X 6, showing astrorhizae leading toward centre of mamelon; superposed pillars and cyst like laminae distinct; 2, type no. 9785 a, horizontal section, X 6, showing well defined astrorhizal systems. (p. 36)

Figs. 3, 4--*Stromatopora mononensis* Galloway and St. Jean, from Canadian Seaboard Keg River no. 6-11; 3, type no. 5907 a, vertical section, X 15, showing prominent laminae and pseudozooidal tubes; 4, type no. 5907 a, horizontal section, X 15, showing distinctly maculate tissue and galleries. (p. 31)


PILLARS FORMING COLUMNS
LAMINAE OR UPWARD CURVED TABULAE
MAMELON
ASTRORHIZAE SYSTEM

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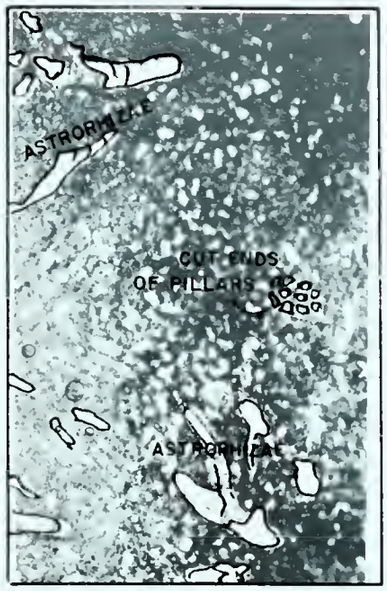
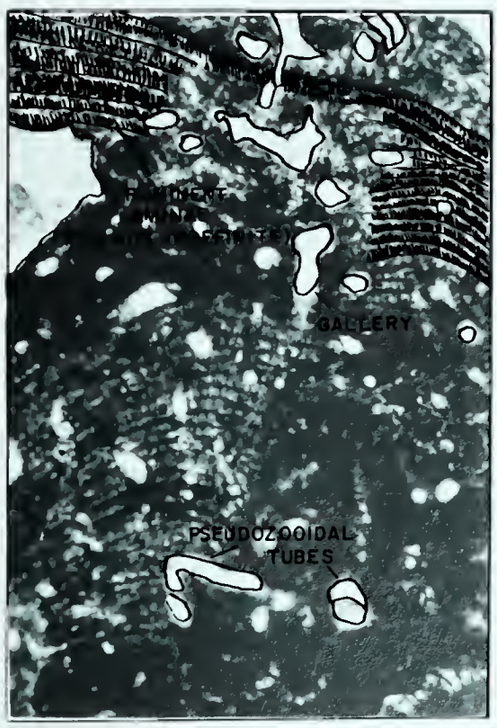

ASTRORHIZAE
CUT ENDS OF PILLARS
ASTRORHIZAE

2.

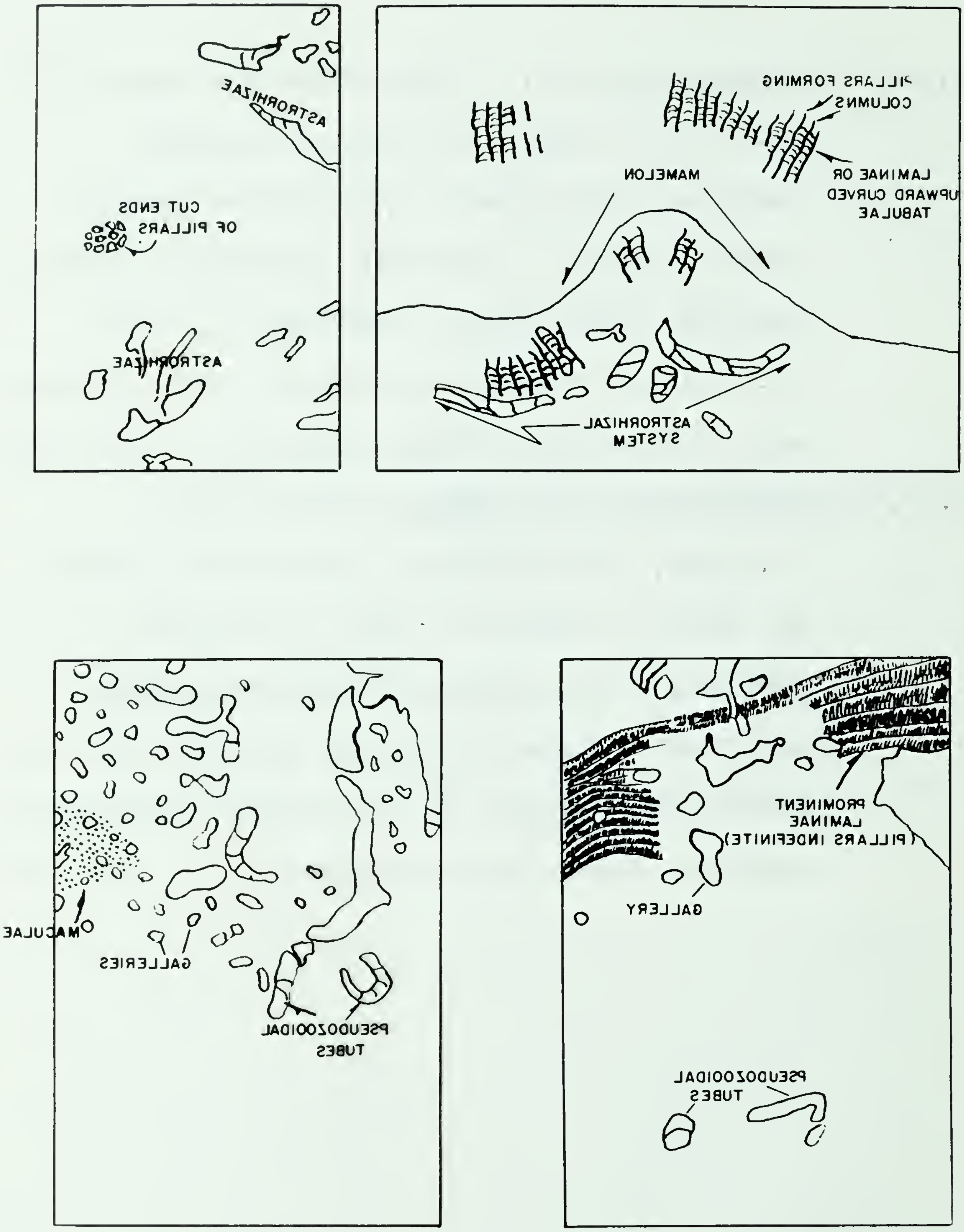

GALLERY
PSEUDOZOOIDAL TUBES

3.


MACULAE
GALLERIES
PSEUDOZOOIDAL TUBES

4.

PLATE 2


ASTRORHIZAE
CUT ENDS OF PILLARS
ASTRORHIZAE
PILLARS FORMING COLUMNS
LAMINAE OR UPWARD CURVED TABULAE
MAMELON
ASTRORHIZAL SYSTEM
MACULAE
GALLERIES
PSEUDOZOOIDAL TUBES
PROMINENT LAMINAE (PILLARS INDEFINITE)
GALLERY
PSEUDOZOOIDAL TUBES

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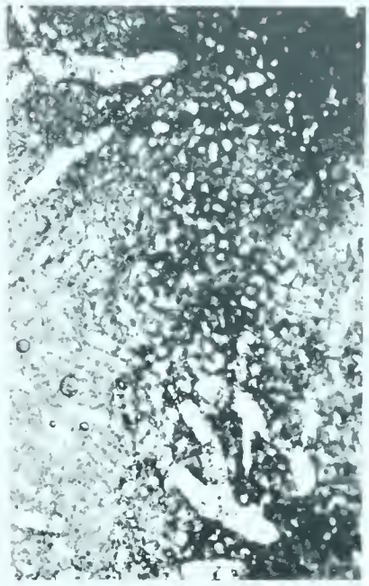

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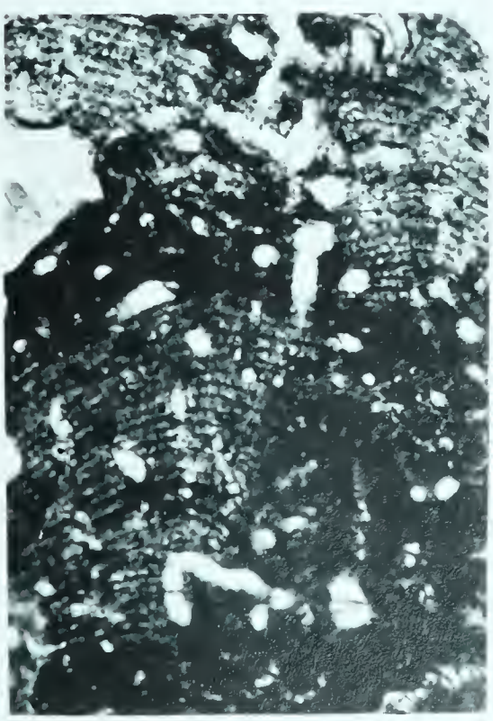

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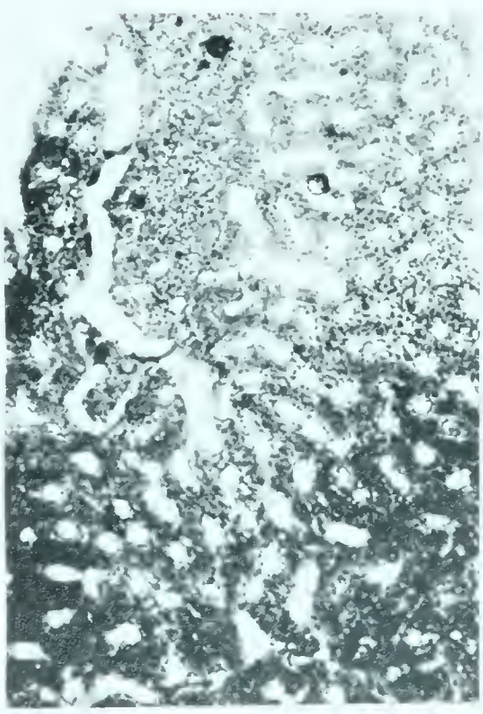

4.

PLATE 2

EXPLANATION OF PLATE 3

Fig. 1 --*Stromatopora* sp. *D*, from Phillips Kaybob "A" no. 7-22; 1, type no. 9627 a, vertical section, X 2½, showing prominent latilaminae and indistinct pillars and laminae. (p. 35)

Figs. 2, 3--*Stromatopora* sp. *A*, from Phillips Kaybob "A" no. 7-22; 2, type no. 9626 f, horizontal section, X 20, showing pseudozooidal tubes with dark surrounding rims; 3, type no. 9626 a, vertical section, X 20, showing a tabulate pseudozooidal tube. (p. 32)

Figs. 4, 5--*Stromatopora* sp. *C*, from Phillips Kaybob "A" no. 7-22; 4, type no. 9622 a, horizontal section, X 6, showing a radiating, branching astrorhizal system; 5, type no. 9622 c, vertical section, X 6, through a thin encrustation revealing several astrorhizal canals in a poorly defined pillar-laminar system; also a vague latilamina. (p. 34)

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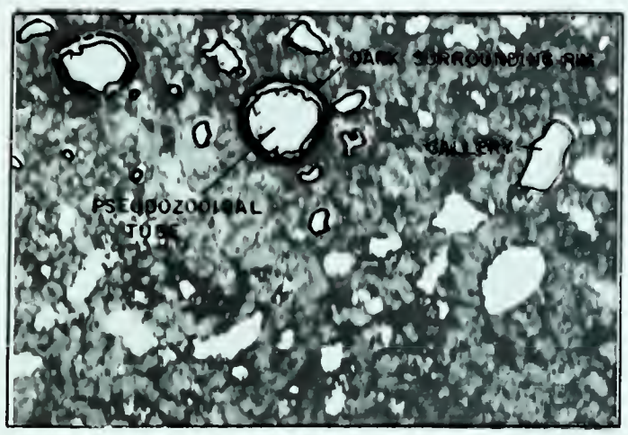

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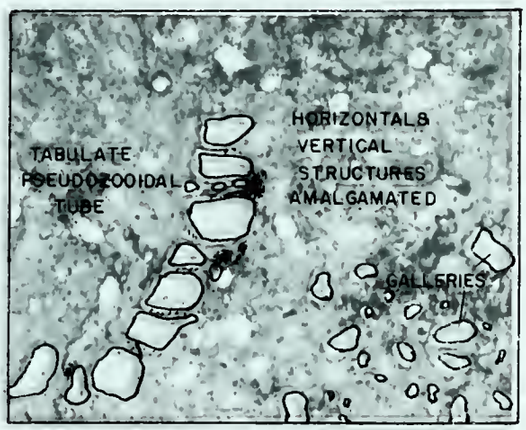

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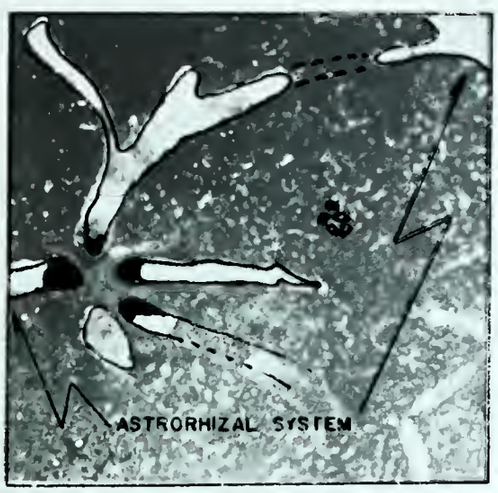

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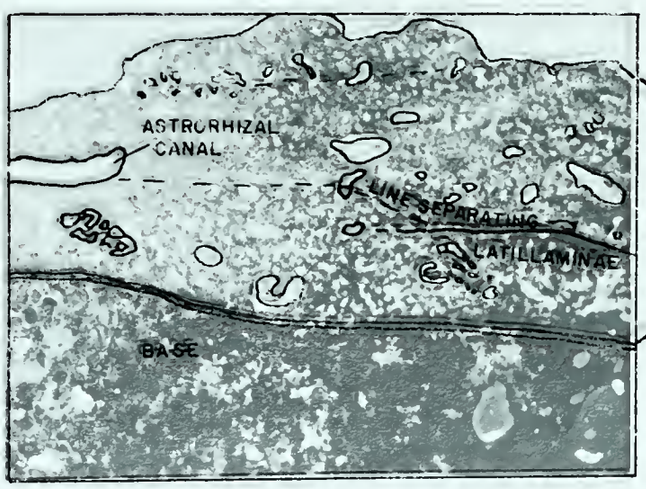

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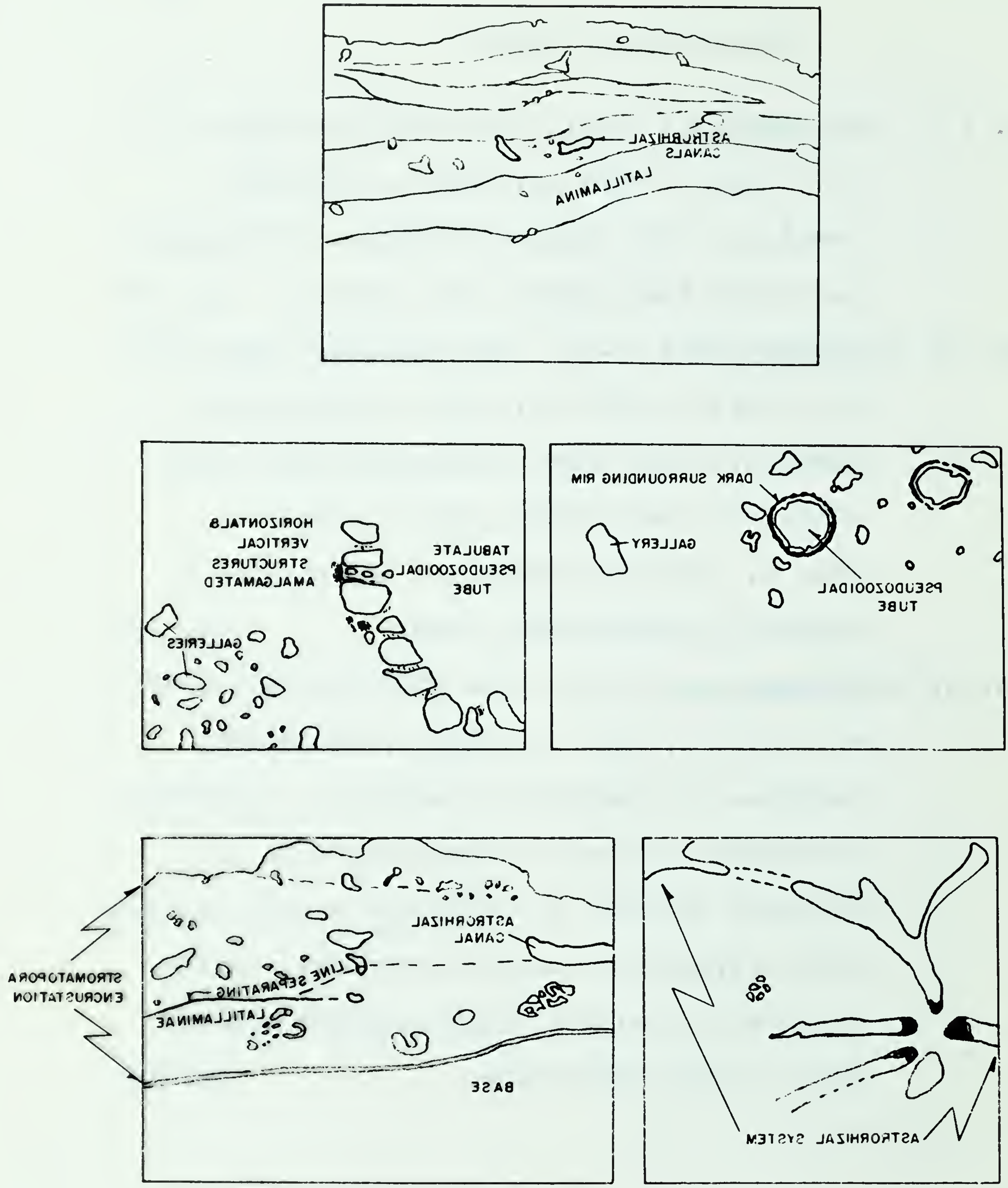
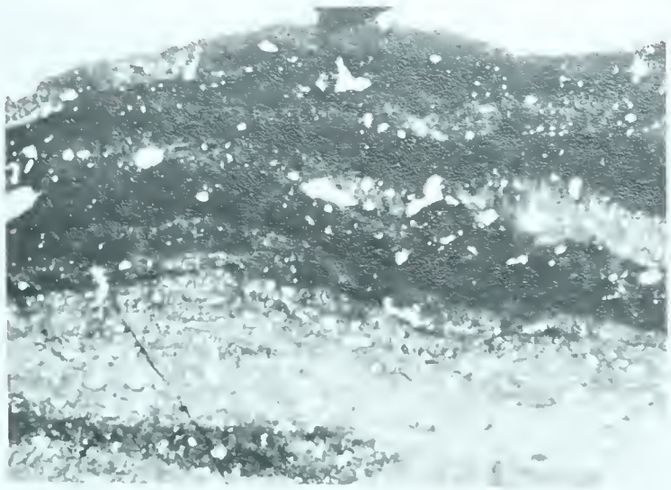
PLATE 3



ASTRORHIZAL CANALS
LATILLAMINA
HORIZONTAL & VERTICAL STRUCTURES AMALGAMATED
TABULATE PSEUDOZOOIDAL TUBE
GALLERIES
DARK SURROUNDING RIM
GALLERY
PSEUDOZOOIDAL TUBE
STROMATOPORA ENCRUSTATION
ASTRORHIZAL CANAL
LINE SEPARATING LATILLAMINAE
BASE
ASTRORHIZAL SYSTEM



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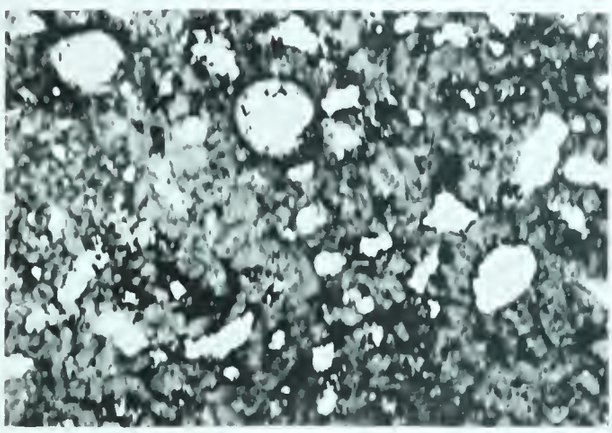

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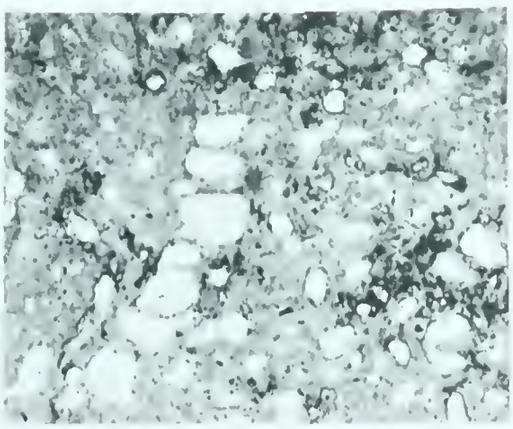

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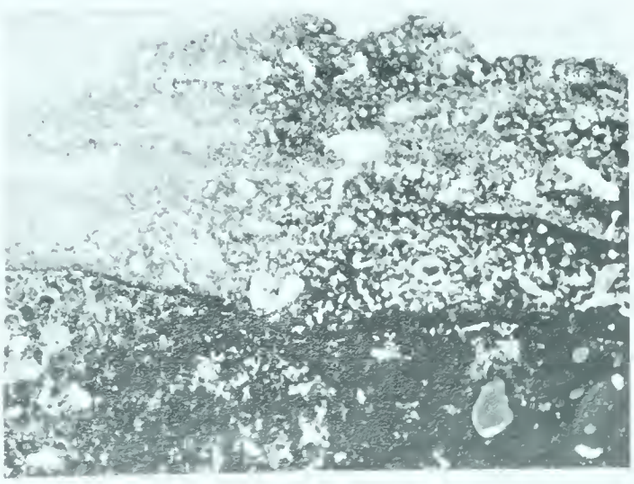


5.

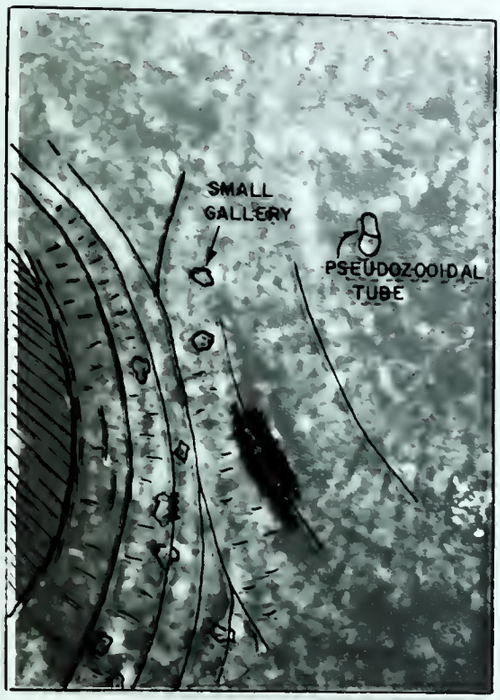
PLATE 3

EXPLANATION OF PLATE 4

Figs. 1, 2--*Stachyodes* sp. *C*, from Phillips Kaybob "A" no. 7-22; 1, type no. 9700 a, magnified portion of fig. 2, X 16, showing thick laminae outlined by dark lines; no evidence of pillars; 2, type no. 9700 a, vertical section, X 2, of a branching coenosteum; small axial tubes, marginal pseudozooidal tubes and lack of pillars differentiate it from *Amphipora*. (p. 42)

Fig. 3 --*Stachyodes* sp. *B*, from Phillips Kaybob "A" no. 7-22; 3, type no. 9641 a, cross section, X 7, showing laminae, pseudozooidal tubes and marginal pseudozooidal tubes. (p. 41)

Figs. 4, 5--*Stachyodes* sp. *A*, from Phillips Kaybob "A" no. 7-22; 4, type no. 9641 a, vertical section, showing marginal pseudozooidal tubes and interior pseudozooidal tubes; laminae indefinite; 5, type no. 9641 a, magnified portion of fig. 4, X 14, showing tabulae in marginal pseudozooidal tubes. (p. 40)



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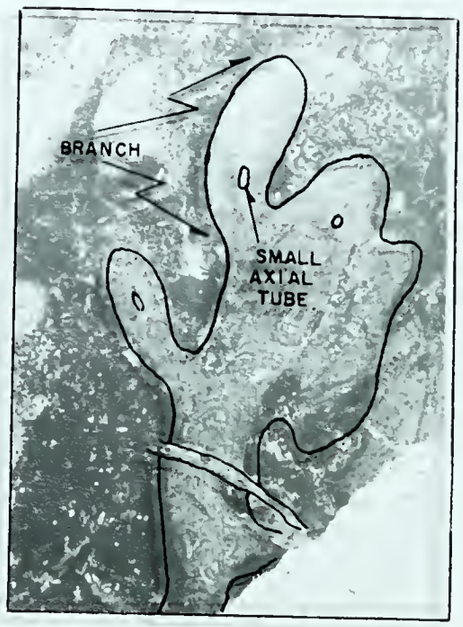

2.

3.

4.

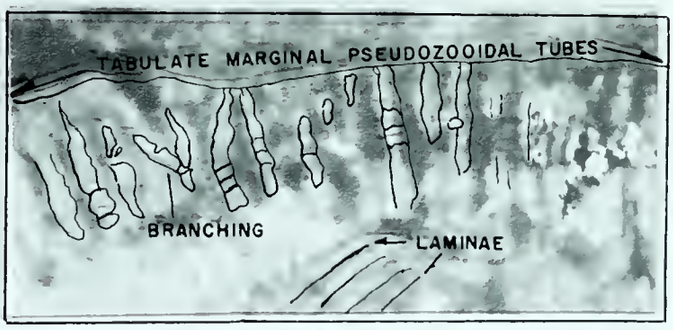

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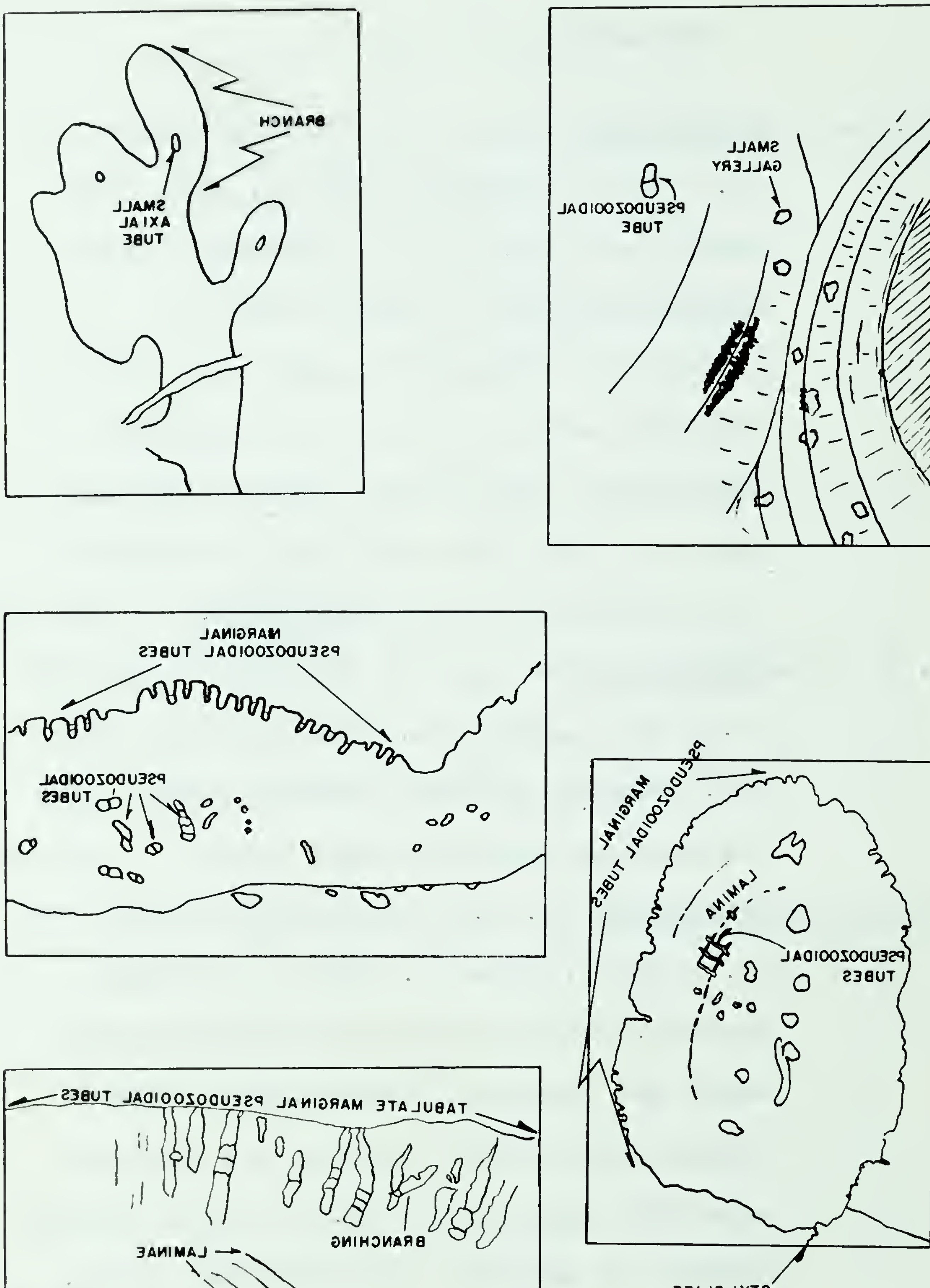
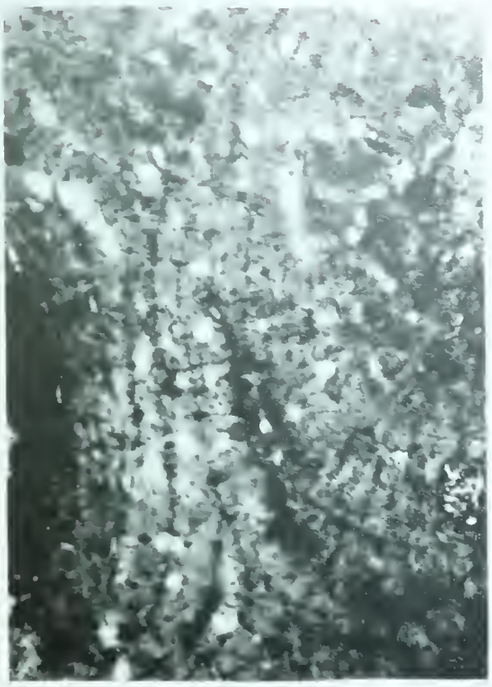
PLATE 4


BRANCH
SMALL
AXIAL
TUBE
SMALL
GALLERY
PSEUDOZOOIDAL
TUBE
MARGINAL
PSEUDOZOOIDAL TUBES
PSEUDOZOOIDAL
TUBES
MARGINAL
PSEUDOZOOIDAL TUBES
LAMINA
PSEUDOZOOIDAL
TUBES
STYLOLITE
TABULATE MARGINAL PSEUDOZOOIDAL TUBES
BRANCHING
LAMINAE



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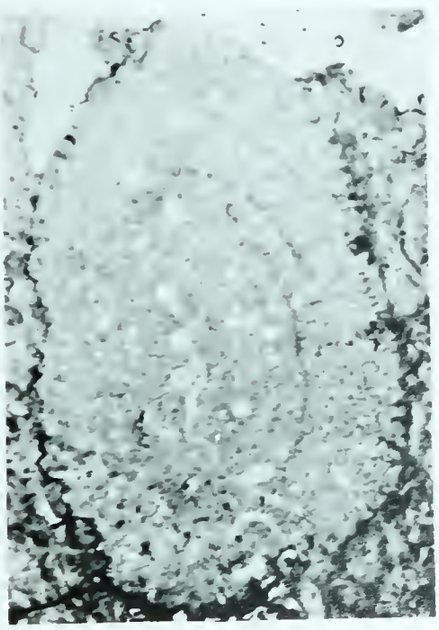

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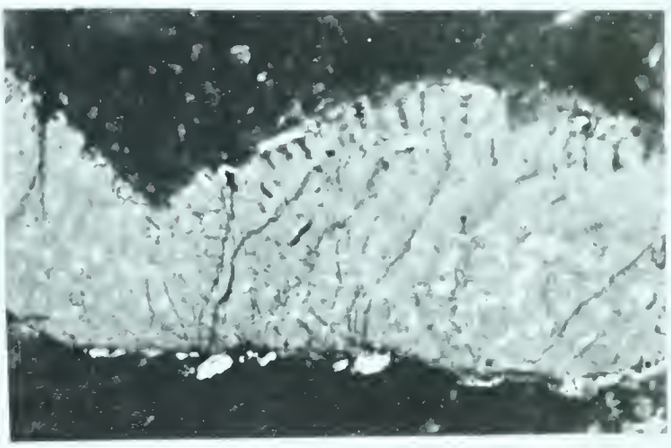

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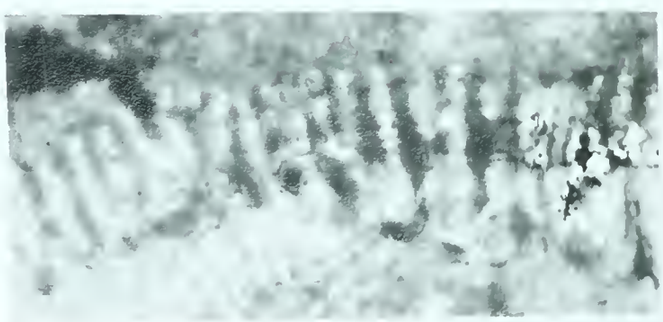
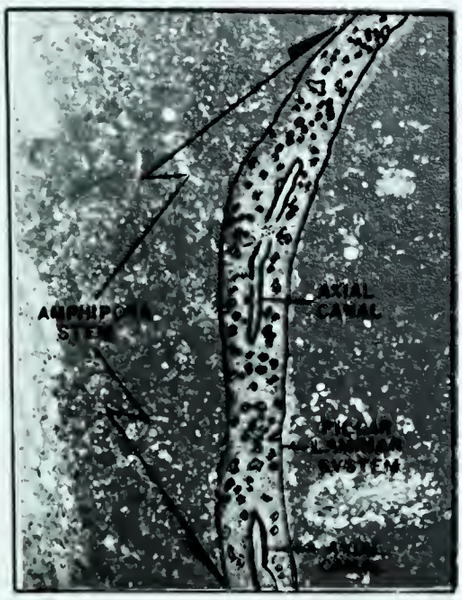


5.

PLATE 4

EXPLANATION OF PLATE 5

Figs. 1-6--*Amphipora* sp. *A*; 1, from California Standard Iosegun Lake no. 7-33; type no. 9902 a, vertical section, X 2½, showing a distinct axial canal; 2, from California Standard Iosegun Lake no. 7-33; type no. 9902 a, vertical section, X 2½, showing an axial canal and distinct marginal vesicles; 3, from California Standard Iosegun Lake no. 7-33; type no. 9908 b, oblique section, X 5, showing arched laminae and diverging pillars; 4, from Canadian Seaboard Cadotte no. 15-24; type no. 5433 a, vertical tangential section, X 16, showing dark median lines with transverse fibres in pillar-laminar system; 5, from California Standard Iosegun Lake no. 7-33; type no. 9902 b, cross sections, X 2½, of several coenostea; 6, from Canadian Seaboard Cadotte no. 15-24; type no. 5424 a, cross section, X 20, showing dark median lines with transverse fibres in pillar-laminar system. (p. 46)



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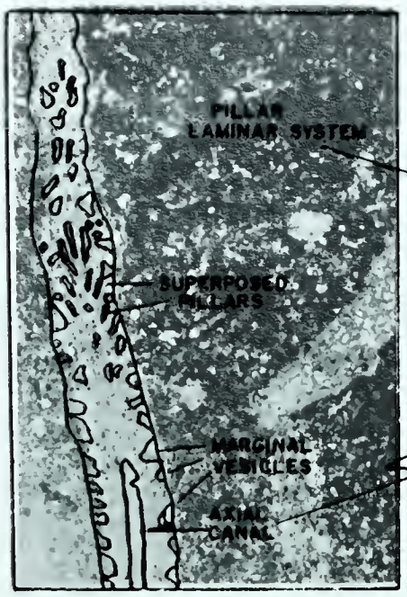

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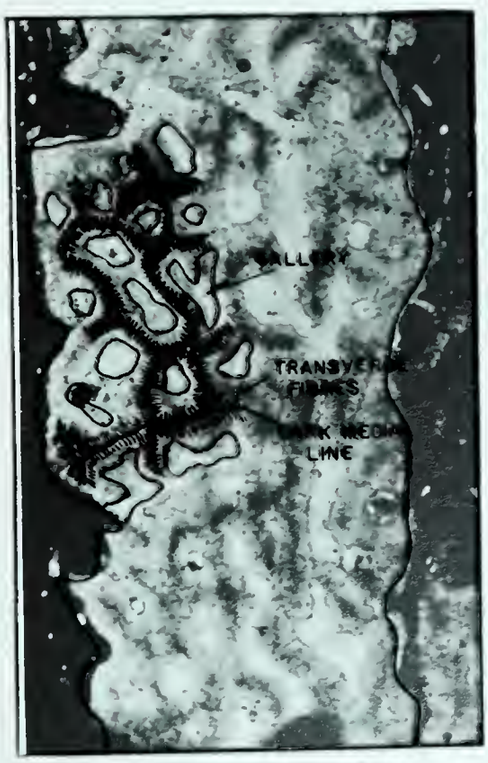
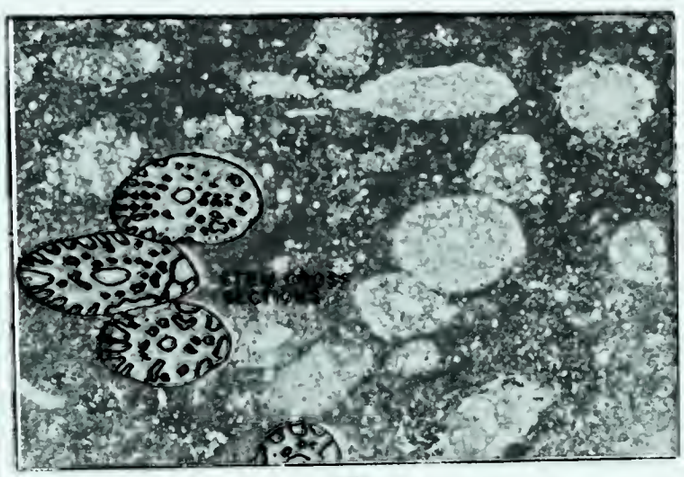


4. DARK MEDIAL LINE



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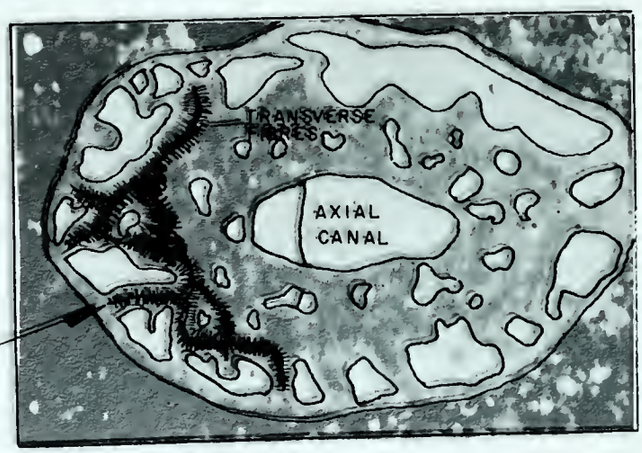
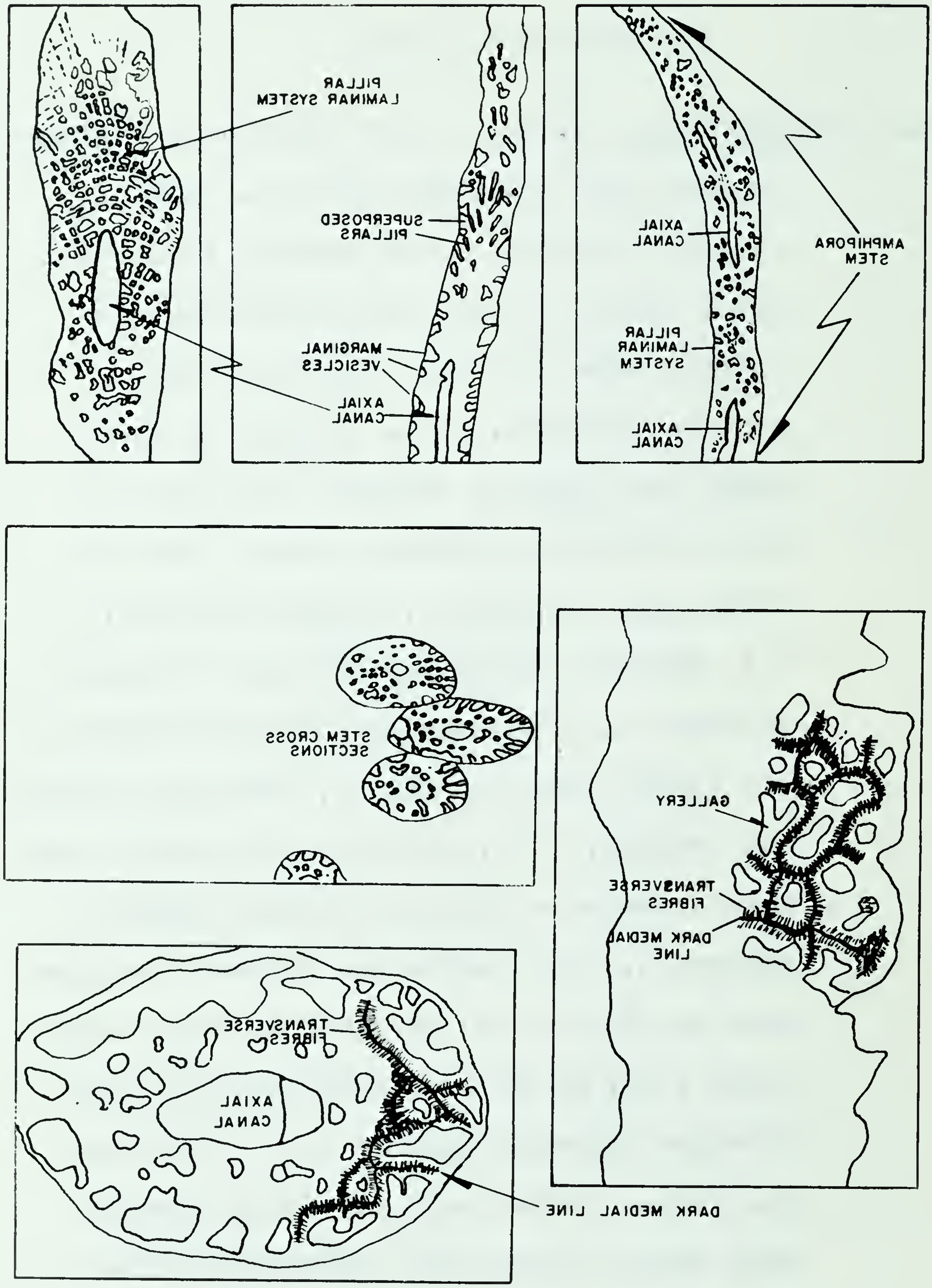
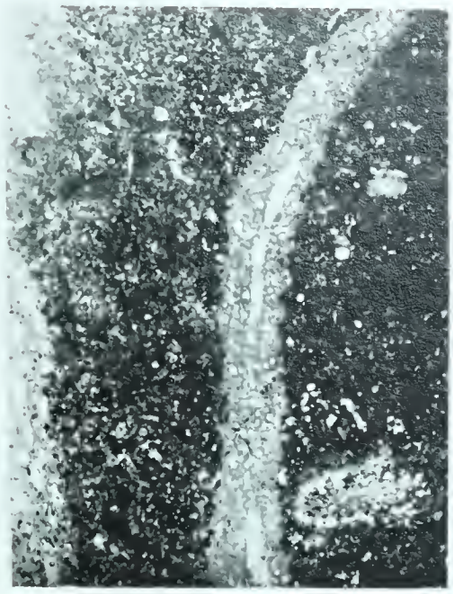


6.

PLATE 5


PILLAR LAMINAR SYSTEM
SUPERPOSED PILLARS
MARGINAL VESICLES
AXIAL CANAL
AXIAL CANAL
AMPHIPORA STEM
PILLAR LAMINAR SYSTEM
AXIAL CANAL
STEM CROSS SECTIONS
GALLERY
TRANSVERSE FIBRES
DARK MEDIAL LINE
TRANSVERSE FIBRES
AXIAL CANAL
DARK MEDIAL LINE



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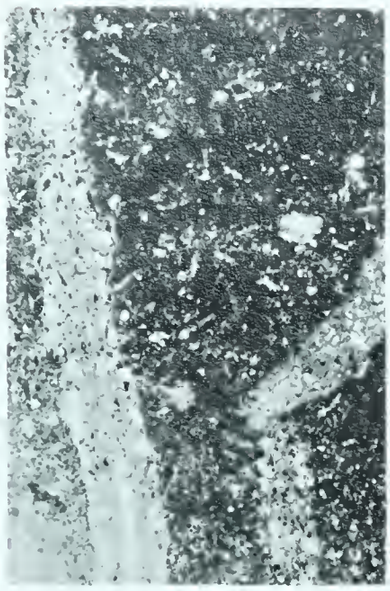

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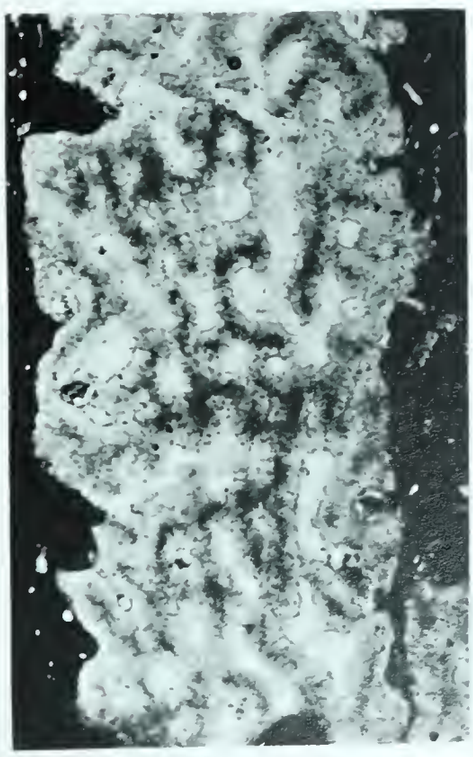

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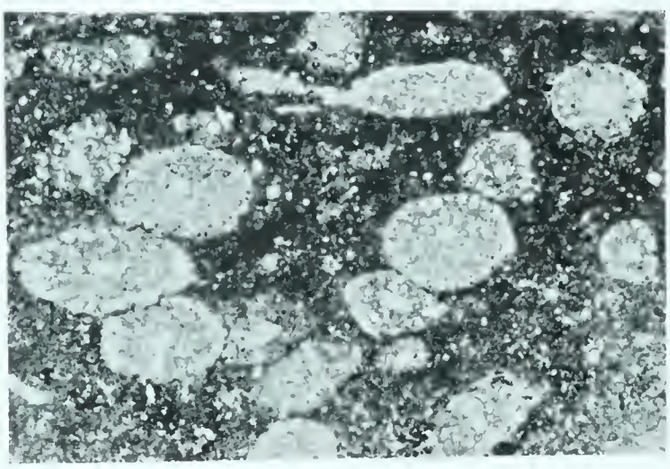

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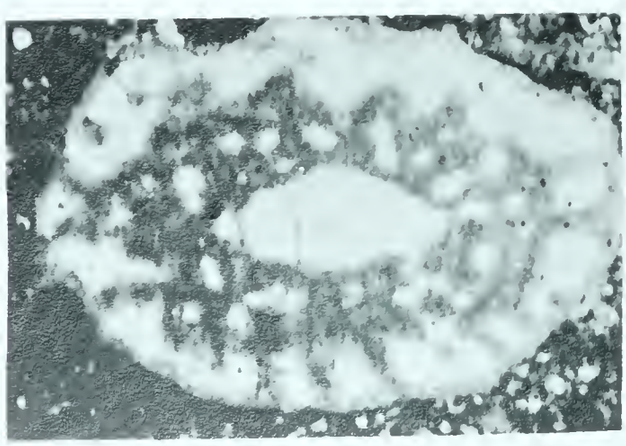

6.

PLATE 5

REFERENCES

Beach, F. K. (1959): Swan Hills Member. Canadian Oil and Gas Industries, Vol. 12, No. 2, p. 32. (Report of a talk given by G. Fong).

Belyea, H. R., and McLaren, D. J. (1957): Upper Devonian Nomenclature in Southern Alberta. Alberta Soc. Petroleum Geol., Jour., Vol. 5, No. 8, p. 166-182.

Crickmay, C. H. (1954): Paleontological Correlation of Elk Point and Equivalents. Ralph Leslie Rutherford Memorial Volume. "Western Canada Sedimentary Basin". Am. Assoc. Petroleum Geol., p. 143-158.

Crickmay, C. H. (1957): Elucidation of Some Western Canadian Devonian Formations. Imperial Oil Ltd., Calgary, private publication, 14 p.

Fritz, M. A., and Waines, R. H. (1956): Stromatoporoids from the Upper Abitibi River limestone. Geol. Assoc. Canada, Proc., Vol. 8, pt. 1, p. 87-126.

Galloway, J. J., and St. Jean, J., Jr. (1957): Middle Devonian Stromatoporoidea of Indiana, Kentucky, and Ohio. Bull. Am. Paleont., Vol. 37, No. 162, p. 29-296.

Galloway, J. J. (1957): Structure and Classification of the Stromatoporoidea. Bull. Am. Paleont., Vol. 37, No. 164, p. 345-470.

Greiner, H. R. (1956): Methy Dolomite of Northeastern Alberta: Middle Devonian Reef Formation. Am. Assoc. Petroleum Geol., Bull., Vol. 40, No. 9, p. 2057-2080.

Heinrich, M. (1916): On the Structure and Classification of the Stromatoporoidea. Jour. Geol., Vol. 24, No. 1, p. 57-60.

Home Oil Company Limited, Geological Department. (1958): Geological Interpretation (Swan Hills). Canadian Oil and Gas Industries, Vol. 11, No. 7, p. 58-63.

Imperial Oil Limited, Geological Staff. (1950): Devonian Nomenclature in Edmonton Area, Alberta, Canada. Am. Assoc. Petroleum Geol., Bull., Vol. 34, No. 9, p. 1807-1825.

Johnson, J. H. (1956): Ancestry of Coralline Algae. Jour. Paleont., Vol. 30, No. 3, p. 563-567.

Koch, N. G. (1959): Correlation of the Devonian Swan Hills Member, Alberta. Unpublished M.Sc. Thesis, Dept. of Geol., Univ. of Alberta.

Lecompte, M. (1951-1952): Les Stromatoporoides du Devonien Moyen et Superieur du Bassin de Dinant. Inst. Roy. Sci. Nat. Belgique, Mem. 117, p. 216-369.

Lecompte, M. (1956): Stromatoporoidea, in Moore, R. C., Treatise on Invertebrate Paleontology, Part F,. Geol. Soc. Am., p. F107-F144.

McLaren, D. J. (1955): Devonian Formations in the Alberta Rocky Mountains between Bow and Athabasca Rivers. Geol. Surv. Canada, Bull. 35, 59 p.

Miller, A. K., and Warren, P. S. (1936): A Timanites from Upper Devonian Beds of America. Jour. Paleont., Vol. 10, No. 7, p. 632-636.

Nicholson, H. A. (1886c, 1889, 1891b, 1892): A Monograph of the British Stromatoporoids. Paleont. Soc. London, Vols. 39, 42, 44, 46, pts. 1-4, p. 1-234.

Parks, W. A. (1933): New Species of Stromatoporoids, Sponges, and Corals from the Silurian Strata of Baie des Chaleurs. Univ. Toronto Studies, Geol. Ser., No. 33, p. 1-40.

Parks, W. A. (1935): Systematic Position of the Stromatoporoidea. Jour. Paleont., Vol. 9, No. 1, p. 18-29.

Parks, W. A. (1936): Devonian Stromatoporoids of North America. Univ. Toronto Studies, Geol. Ser., No. 39, p. 1-125.

Shrock, R. R., and Twenhofel, W. H. (1953): Principles of Invertebrate Paleontology. Second Edition. McGraw-Hill Series in Geology, p. 111-116.

Stearn, C. W. (1958): A Stromatoporoid Fauna from the Devonian of Alberta. (Script of talk given by the author).

Taylor, P. W. (1957): Revision of Devonian Nomenclature in the Rocky Mountains. Alberta Soc. Petroleum Geol., Jour., Vol. 5, No. 8, p. 183-195.

Twenhofel, W. H. (1950): Coral and other Organic Reefs in Geologic Column. Am. Assoc. Petroleum Geol., Bull., Vol. 34, No. 2, p. 182-202.

Warren, P. S. (1949): Fossil Zones of Devonian of Alberta. Am. Assoc. Petroleum Geol., Bull., Vol. 33, No. 4, p. 564-571.

Warren, P. S., and Stelck, C. R. (1949): The Late Middle Devonian Unconformity in Northwestern Canada. Trans. Roy. Soc. Canada, Vol. 43, Ser. 3, Sec. 4, p. 139-148.

Warren, P. S., and Stelck, C. R. (1954): The Stratigraphic Significance of the Devonian Coral Reefs of Western Canada. Ralph Leslie Rutherford Memorial Volume. "Western Canada Sedimentary Basin". Am. Assoc. Petroleum Geol., p. 214-218.

Warren, P. S. (1957): The Slave Point Formation. Edmonton Geol. Soc., Vol. 1, No. 1, p. 1-2.

APPENDIX

Glossary of structural terms used in this thesis that apply to Stromatoporoidea.

AMALGAMATED. United without visible suture; coalesced or fused. Used particularly for the condition of the union of the horizontal and vertical structures in the family Stromatoporidae (Pl. 1, fig. 5).

ASTRORHIZAE. A group of radiating, branching grooves, generally centering at a mamelon and superposed in the axis of a mamelon, but not usually superposed when there are no mamelons. In vertical sections appearing as large, round, horizontal pores, or as vertical or oblique, tabulate tubes. Commonly present in members of the family Stromatoporidae (Pl. 3, fig. 4); may occur in Actinostromatidae; not typically developed in Idiostromatidae. Astrorhizae occur in many genera of the Hydrozoa other than Stromatoporoidea.

COMPACT. Homogeneous, not alveolar, porous or maculate, nor dense like a mineral crystal or glass, but made of crystals of calcite closely appressed, as in Actinostromatidae.

DENDRITIC. Repeatedly branching, as a tree. Typical of Idiostromatidae (Pl. 4, fig. 2). Also the branching

canals of astrorhizae (Pl. 3, fig. 4).

DENSE TISSUE. Apparently solid, compact and homogeneous, excepting for small, granulose calcite crystals. Not dense like glass, but finely crystalline. Not porous and maculate, as in the Stromatoporidae. Actinostroma has typically "dense" tissue. Compact is the better term.

FIBROUS. Composed of short strands transverse to the laminae, as in Amphipora (Pl. 5, fig. 4).

GALLERIES. Interlaminar spaces, traversed by pillars, not by vertical walls, in life occupied by part of the soft body of the animal or abandoned after a new lamina was laid down. Sometimes less aptly called chambers and cells. (Pl. 1, fig. 1).

HORIZONTAL SECTION. A section parallel to the laminae or latilaminae, when the laminae curve a little, as in lenticular specimens. When the laminae curve much, the section is tangential. Usually referred to as the "tangential section".

HYDRACTINOID. Having pillars distinct from laminae or horizontal processes, much as in the hydroid genus Hydractinia. Tissue of neither pillars nor laminae is maculate and porous, nor vesicular. Refers to all genera excepting those in the families Stromatoporidae and Idiostromatidae.

INTERLAMINAR SPACES. Galleries, cavities, spaces or chambers between laminae. Spaces are more aptly designated as galleries. Spaces are high in genera with thin walls, as Actinostroma; and narrow or more or less completely filled with porous and maculate tissue in the Stromatoporidae. Interlaminar spaces are partly filled by pillars, partly by secondary tissue and partly by dissepiments.

LAMINA,-AE. Thin, parallel or concentric layers making up most of the coenostea. They are fundamental structures of most stromatoporoids, modified from cyst plates of Labechiidae. Primary or original laminae are thin. In most genera, laminae have been thickened by secondary layers deposited above and below primary laminae. Primary laminae are inconspicuous in Stromatoporidae and Idiostromatidae, but are usually detectable (Pl. 1, fig. 1).

LAMINAR. In layers, whether thin or thick, as seen with the unaided eye or with a low-power hand lense, and in most slightly weathered stromatoporoids.

LATILAMINA,-AE. Thick layers, 1 to 20 mm. in thickness, in turn composed of many laminae or cysts; seen in most weathered specimens of stromatoporoids (Pl. 3, fig. 1). They may or may not be in specimens of the same species; they seem to be due to pauses in growth,

reproductive or perhaps seasonal pauses, and are without taxonomic significance. Curved latilaminae make stromatoporoids distinguishable in the field from mere pieces of rock, but do not distinguish stromatoporoids from stromatolites.

MACULATE. Having dark or light spots or dots in a gray groundmass. Dots are 0.01 to 0.06 mm. in diameter, typically with clear centers and occur in laminae, pillars and secondary tissue, typically seen in Stromatopora (Pl. 2, fig. 4). Maculate structure is characteristic of the family Stromatoporidae, contrasting with the compact, fibrous, and homogeneous tissue structure of the other four families.

MAMELONS. Round, regular or irregular elevations on the surface. They vary from 2 to 15 mm. in diameter and 1 to 8 mm. high. They may be solid or occupied by a tube, frequently have astrorhizae at the summits and throughout the columns which make the mamelons (Pl. 2, fig. 1 and Pl. 1, fig. 4).

PILLARS. Small, vertical structures between laminae (short), or passing through many laminae, (long, continuous). Pillars are substantially solid or compact, as in Actinostroma; maculate and porous, as in Stromatopora. Pillars are smaller than columns. They may be round, irregular, branched and frequently

divide and expand in the laminae, making vermicular, areolate and odd patterns in tangential sections. Pillars are mostly built on the primary lamellae and are frequently superposed. They apparently go through the laminae, as in Actinostroma (Pl. 1, fig. 1). Pillars are mostly primary structures, as in Actinostromatidae; some are secondary, as the short pillars of Stromatopora.

PSEUDOZOOIDAL TUBES. Vertical tubes or superposed and restricted galleries, irregular in cross section, incidentally round, generally crossed by thin tabulae, the remnants of laminae; characteristic of Stromatoporidae and Idiostromatidae (Pl. 3, fig. 3). They have been called "zooidal tubes", but there is little or no evidence that they were occupied by zooids.

RADIAL PROCESSES. Arms in whorls extending from pillars, as in Actinostroma.

RAMOSE. Referring to round, erect and branching coenostea, as in Amphipora (Pl. 5, fig. 5).

RETICULATE. Like a net, referring to the network of laminae and pillars (Pl. 1, fig. 5).

TABULAE. Thin, flat, or curved structures in vertical tubes or between superposed galleries, either distinct structures or the remnants of laminae, as in Stromatopora (Pl. 2, fig. 1).

TANGENTIAL. Refers to a section as nearly parallel with the laminae as possible, especially as applying to small, globular or ramose forms, and in descriptions called the "tangential section" (Pl. 5, fig. 4).

TISSUE. Microscopic structure or histology of laminae, pillars, cysts or other finer structures. Sometimes called "ultimate fibre" (Parks, 1936, p. 8) but not actually the finest calcite granules compose the skeleton. The word "fibre" is not appropriate, since the substance is not composed of threadlike bodies.

VESICLE. Small vacuities, as in the margins of Amphipora (Pl. 5, fig. 6).